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**The FCC's Broadband Over Power Line Inquiry:
Considering Radio-Frequency Interference
Rules of the Road for the
Third High-Speed Communications Wire**

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I. Introduction¹

The Federal Communications Commission (Commission) recently launched a narrow yet critical proceeding² that could help decide whether the nascent technology of delivery of high-speed communications via electric utility power lines enjoys success in an increasingly crowded landscape of broadband providers.

The proceeding is examining radio frequency (RF) interference and other technical concerns raised by the deployment of broadband over power line (BPL) systems.³ The proceeding is narrow in scope: issues were limited to radio frequency interference and other BPL technology matters. Deliberately postponed were consideration over a number of related regulatory areas, such as the right of BPL providers to access rights-of-way, poles, conduits controlled by other utilities; rights of other broadband providers to access electric utility wires and equipment used by BPL system operators; the statutory classification and regulatory treatment of BPL, as compared to the regulatory status of other forms of broadband; and the duty of BPL providers to offer service to disadvantaged residents in their service areas on preferential terms.⁴

Instead, the BPL proceeding focuses on the less sensational issue of whether the Commission should allow operations by BPL technology providers under the Commission's existing Part 15 rules⁵, which allow use of spectrum on an unlicensed basis and, if so, whether those rules should be tailored to BPL. Despite its limited scope, the proceeding is of fundamental concern to the technology: power lines are effective radiators of RF energy and some forms of BPL could interfere with services in the surrounding airwaves and might also be conducted along wiring onto adjacent electrical devices and thereby cause interference. BPL advocates generally concede that the degree of RF interference limitations imposed by the FCC (or related legal challenges or regulatory

¹ The authors wish to thank numerous participants in the Broadband Over Power Line proceeding for their thoughtful suggestions regarding this article. A particular debt is owed to Bruce Franca of the Commission's Office of Engineering and Technology; Brett Kilbourne, United Power Line Council; Raymond Kowalski, Troutman Saunders, LLP; Christopher Imlay, National Association for Amateur Radio; Mitchell Lazarus, Fletcher, Heald & Hildreth, PLC; Richard D'Angelo, North American Shortwave Association; and David Shpigler, Electric Broadband and the Shpigler Group. The opinions expressed in this Article, and any errors it contains, are exclusively those of the authors.

² Notice of Inquiry, In re Inquiry Regarding Carrier Current Systems, including Broadband over Power Line Systems, 18 F.C.C.R. 8498 (2003) [hereinafter BPL NOI].

³ Delivery of high-speed communications has usually been described by proponents as power line communications. The Commission introduced the term "Broadband Over Power Line" [hereinafter BPL] in the *Notice of Inquiry*. This article will use the BPL designation.

⁴ See BPL NOI, *supra* note 2 (Separate Statements of Commissioner Copps and Commissioner Adelstein) (noting the Commission's exclusion of issues such as pole attachments, affiliate transactions, and universal service from the scope of the NOI). Many of these issues involve state-jurisdictional components. On December 16, 2003, the National Association of Regulatory Utility Commissioners announced that a six-person task force would explore broadband over power line and the role of state regulators in advancing BPL technology. Dinesh Kumar, Wireline, COMMUNICATIONS DAILY, Dec. 17, 2003. It also is possible that the Federal Energy Regulatory Commission will have a role in regulating BPL.

⁵ 47 C.F.R. Part 15 (2003).

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uncertainty caused by the lack thereof) are one of, if not the greatest, regulatory variables faced by BPL and one whose determination could greatly impact the feasibility of a technology whose deployment lags behind established broadband delivery mechanisms, such as cable modem and DSL. Severe emissions or bandwidth constrictions placed upon BPL delivery could mark a final setback for the industry, which has been plagued by failure to deliver on past technological promises. "Whether utilities offer commercial services will be determined in large part by the technical rules that the FCC adopts for BPL."⁶ The proceeding is also of fundamental concern to many spectrum licensees (and possibly unlicensed spectrum users) who contend that BPL technology will irretrievably compromise their use of the spectrum. A comment and reply comment cycle yielded more than 4,600 comments, most by amateur radio operators concerned by what they contend is a mortal threat to their access to the airwaves.

In addition, the proceeding has served as a reality check for a nascent industry that has in the past relied on promises of future performance. The Commission's request for as detailed information as possible has led BPL proponents to provide the first official, industry-wide record of BPL status with respect to a number of areas.

An initial statement by the Commission regarding its intended approach toward the issues raised is expected by the end of first quarter 2004, likely in the form of a Notice of Proposed Rule Making requesting comment on concrete technical issue rule proposals.

This Article will examine the issues raised by the proceeding, the viewpoints of various participants and the evidence they presented, and past Commission experience managing RF interference issues. It concludes that while further testing is necessary to gauge the RF interference threat of BPL systems, the Commission should allow systems to be deployed under existing Part 15 rules provided they are carefully monitored for actual interference and forced to desist or adjust frequencies in such cases. The Commission should not impose standards upon the technology, nor should it ease its existing Part 15 rules in an attempt to foster a third broadband competitor to cable modem and DSL absent a strong showing of lack of interference and due consideration of level broadband playing field concerns. Similarly, the Commission should be cautious in providing incentives for new technology, save for strong encouragement for unequivocally beneficial applications such as the modest goal of encouraging BPL functions that create a more secure, intelligent, and reliable electric grid or build out in economically disadvantageous areas not served by other broadband competitors.

II. The View from 30,000 Feet: BPL in a Nutshell, the Commission's NOI Agenda, the Commenters, and What They Had to Say

Broadband Over Power Line involves the injection of RF energy carrying communications signals into power lines. The NOI divides the industry into two

⁶ UPLC, Comments in ET Docket No. 03-104, 7 (July 7, 2003) [Hereinafter UPLC Comments]. But *see* discussion *infra* at Part V(G) noting that it appears that regulatory issues, while a threshold issue, will drive the success or failure less than the business fundamentals and BPL's competitive offerings.

major categories, including In-House BPL, in which in appliances within a building are linked via power lines terminating in electrical outlets, and Access BPL systems, which injects RF energy from the Internet backbone onto medium or low voltage power lines along which they are delivered to end users through internal wiring or wireless devices and retrieved by users with modems.

In addition to access to the Internet, BPL can facilitate availability of a wide variety of services to end-users. BPL could also extend existing utility system management and reliability functions beyond substations into homes, providing a second source of revenue and savings to utilities. A wide variety of tests have been conducted by BPL technology providers over the past year, and several municipal and investor-owned utility partners announced in late 2003 that they would commercially deploy BPL systems in fourth-quarter 2003 or first-quarter 2004 despite the regulatory uncertainty, though most subsequently pushed back their launch dates.⁷

Under the Commission's current rules, BPL systems are classified as carrier current systems (CCS) that operate on an unlicensed basis under Part 15 of the Commission's rules, under which they must not cause harmful interference⁸ to licensed spectrum users and must accept interference caused by those licensed users. Equipment used in such systems pursuant to Part 15 must comply with Commission authorization procedures. Access BPL providers already conducting tests are doing so pursuant to such approvals or through experimental licenses granted by the Commission.⁹

The Commission asked 82 questions in the NOI that can be narrowed to three basic questions: 1) What is the current state of BPL technology and the

⁷ See WASHINGTON INTERNET DAILY, Aug. 27, 2003 ("Jay Birnbaum, pres. of Current Technologies, which is involved in trials by Cinergy in Cincinnati and PEPCO in Potomac, Md., said the companies were working toward a commercial start in the 4th quarter.") See discussion below at III(F).

⁸ "Interference" is defined by the Commission's rules as "The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy." 47 C.F.R. § 2.1 (2003).

⁹ An experimental license is an authorization under the FCC's Experimental Radio Service, (Part 5 of the Commission's Rules) that allows for the operation of an experimental non-broadcast radio station. See Experimental License Frequently Asked Questions, available at <http://www.fcc.gov/oet/faqs/elbfaqs.html> (Last updated/reviewed March 25, 2002). With respect to licenses granted to BPL technology providers, see Ambient Corporation, File No. 0218-EX-ST-2002, Special Temporary Authority "STA") granted December 24, 2002; Ameren Energy Communications, Inc., File No.

0093-EX-PL-2002, Experimental Authorization ("EA") granted June 5, 2002; Amperion, Inc., File No. 0046-EX-PL-2003, EA granted March 11, 2003; Current Technologies, LLC, File No. 0046-EX-ML-2002, EA granted Sept. 12, 2002; Hawaiian Electric Company, Inc., File No. 0089-EX-PL-2003, EA granted May 22, 2003; PPL Electric Utilities, File No. 0183-EX-PL-2002, EA granted Oct. 1, 2002; Progressive Energy Service Co., File No. 0011-EX-PL-2003, EA granted Feb. 10, 2003; Southern Telecom., Inc., File No. 0126-EX-PL-2002, EA granted Aug. 29, 2002. Each authorization requires that licensees file a progress report every 6 months from the date of the grant of the licensee. The authorization specified that the progress report should include, but is not limited to a description of the measurements and results demonstrating compliance with Part 15.109.

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amount of spectrum and bandwidth needed to facilitate such uses?; 2) How significant are concerns regarding BPL generation of RF interference with competing spectrum users?; and 3) how should interference issues be addressed? As noted, the Commission deliberately excluded from the NOI such thorny issues as where BPL fits into a rapidly evolving Commission classification system for different broadband and non-broadband communications delivery systems, the right of BPL to access to rights of way controlled by other utilities, the rights of other broadband providers to access BPL systems, affiliate issues raised by cooperation between electric utilities and BPL affiliates or partners, and the like.

Significantly, the Commission indicated that rules adopted in the proceeding would be prospective in application: The Commission told BPL providers that they could deploy BPL under current Part 15 rules without fear for retroactive Commission decisions and, in fact, encouraged them to do so.¹⁰

The Commission accepted comments through July 7, 2003 and reply comments through August 20, 2003, though numerous late-filed ex parte filings have also been posted on the Commission's website. The Commenters and the content of their filings generally broke down into four categories:

1. Utilities and their BPL technology provider partners explained how BPL functions, were bullish on the technology, contended that existing tests suggest that interference potential is minimal, and suggested that the industry be allowed to proceed based upon its promise to mitigate problems should interference issues develop. One original technical study was submitted by this group.
2. Licensed users of the spectrum in which BPL would function, including broadcasters, amateur and shortwave radio operators, and radio astronomers, expressed significant to fervid concern regarding possible BPL interference to their systems. Most vociferous by far were the amateur radio operators, who contended that absolute exclusion of BPL from their spectrum band was necessary to protect their systems. Five original technical studies were submitted by this group.
3. Broadband competitors, including cable operators, telephone companies and wireless Internet service providers, expressed similar, if less vigorous concerns regarding possible interference to their systems as did the spectrum users. Generally they proposed further studies before authorizing BPL to use spectrum under Part 15. These commenters also expressed concerns beyond the Commission's stated scope of the proceeding: local exchange carrier commenters stressed the need for broadband regulatory parity with respect to telephone

¹⁰ BPL NOI, *supra* note 2, ¶ 2. BPL providers would, however, still face the possibility of having to alter their systems at a future date to ensure prospective compliance with any future rules adopted by the Commission. *Id.*

companies vis-à-vis less regulated broadband providers, and cable system operators expressed concerns that electric utilities will use their ownership of poles and rights of ways to discriminate against competitors. One group of wireless Internet service providers submitted a technical study.

4. Regulatory commenters included the federal National Telecommunications and Information Administration (“NTIA”), which noted that it was performing interference tests expected to be concluded by the end of the year and which noted a desire to protect existing governmental spectrum users while encouraging the development of a new broadband competitor¹¹, and state regulatory commission commenters, including California, Michigan, and the District of Columbia, which generally expressed desire for a new broadband competitor, but raised issues of state jurisdiction over aspects of BPL systems, and voiced concerns over interference to existing spectrum users.¹²

As noted, the Commission promised unusually speedy progress on the proceeding and publicly stated that it expects initial action, likely in the form of a notice of proposed rulemaking that would outline, and request comment on, possible rules, by the end of the first quarter of 2004. It is likely that the NPRM will inquire whether the proceeding should be expanded to include matters excluded from the NOI and that final technical rules could be released a year later.

III. The State of BPL Technology, How the Technology Works, and Likely Spectrum and Bandwidth Needs

A. Benefits

Three classes of benefits were identified by BPL: benefits for end users, benefits for utilities, and national and public safety benefits.

1. Benefits for End Users

For In-House BPL systems, BPL technology providers touted benefits include networking telephone line extensions, ADSL line extensions, advanced computer gaming, computer networking, home automation systems, and

¹¹ NTIA, Comments in ET Docket No. 03-104 (Aug. 13, 2003) [hereinafter NTIA Comments].

¹² California Public Utilities Commission, Reply Comments in ET Docket No. 03-104, 2 (Sept. 4, 2003)(calling for interference testing and standards and for Commission affirmation of the CPUC’s right to regulate all telecommunications services offered through BPL, set utility rate charges, prosecute unlawful utility marketing and billing activities, govern business relationships between utilities and their affiliates, and to resolve complaints by consumers against BPL service providers); Michigan Public Service Commission, Reply Comments in ET Docket No. 03-104 (Aug. 19, 2003); Office of the People’s Counsel, District of Columbia, Comments in ET Docket No. 03-104 (July 7, 2003)[hereinafter OPC Comments].

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improved audio and video home entertainment performance.¹³ The Commission noted that the average United States home has fewer than 5 telephone jacks and cable TV connections but may have 10 times as many AC outlets.¹⁴

With respect to Access BPL systems, BPL providers said such systems would benefit users who do not otherwise have high-speed Internet access.¹⁵ Foremost among them are rural end users, who lack broadband options in many markets.¹⁶ However, even advocates of rural broadband access questioned whether BPL will provide large-scale service to rural regions in the near future because of economic disincentives to BPL buildouts.¹⁷ Commenters also suggested that additional broadband competition will bring down broadband delivery prices.¹⁸ While the uses of broadband are as numerous as those of the Internet, the Access BPL commenters did not provide evidence of any end user applications particular to BPL, save for limited energy-related functions. This is

¹³ Phonex Broadband Corp., Comments in ET Docket No. 03-104, 1 (July 7, 2003) [hereinafter Phonex Comments].

¹⁴ BPL NOI, *supra* note 2, ¶ 9 n.14.

¹⁵ See, e.g., Southern, Reply Comments in ET Docket No. 03-104, 2 (Aug. 20, 2003) [hereinafter Southern Reply Comments] (BPL would allow communications connectivity to virtually all customers and devices connected to the grid); Net2Phone, Comments in ET Docket No. 03-104, 3 (July 7, 2003) [hereinafter Net2Phone Comments] (No new infrastructure costs, allowing more rapid deployment); see also PLCA, Comments in ET Docket No. 03-104, 2 (July 7, 2003); Cinergy, Comments in ET Docket No. 03-104, 3 (July 7, 2003) [hereinafter Cinergy Comments] (Allow expansion of service to rural and isolated area that do not currently receive service from DSL or cable modem providers); Public Safety Wireless Network, Comments in ET Docket No. 03-104, 1,4 (July 7, 2003) [hereinafter PSWN Comments]; Amperion, Comments in ET Docket No. 03-104, 10 (July 7, 2003) [hereinafter Amperion Comments]; PPL, Comments in ET Docket No. 03-104, 3-4 (July 7, 2003) [hereinafter PPL Comments] (PPL Telecom estimated that out of a population of 375,000 PPL Electric customers evaluated for potential BPL service . . . more than two-thirds of these customers do not now have access to equivalent two-way broadband access."); OPC Comments, *supra* note 12, at 2. (The District of Columbia's Office of the People's Council noted that technical limitations inherent to DSL technology meant that DSL could not provide broadband telecommunications service through all parts of the city).

¹⁶ See National Rural Telecommunications Cooperative and the National Rural Electric Cooperative Association, Joint Reply Comments in ET Docket No. 03-104, 4 (Aug. 20, 2003) [hereinafter NRTC/NRECA Reply Comments].

¹⁷ *Id.* at 6 (Stating that a recent study "suggests that BPL will not be a viable solution for most Americans in truly rural areas any time soon. The very limited deployment of BPL technology within the U.S. involves traversing only a mile or two of power distribution lines in areas with relatively dense population. . . . To date, no BPL system has been demonstrated to work, much less been commercially developed, on a long sparsely populated rural electric power line."). The NRTC/NRECA noted that the economics of such service would likely be prohibitive because of the need for signal repeaters and need for network access points and backhaul lines to NAPs to connect them to the rural backbone. *Id.* Interestingly, however, subsequent to the comment period, BPL Technology provider Amperion announced that it had successfully conducted trials with energy utility AEP on high-voltage transmission wires, one of, if not the, first trials on high-voltage wires. Kurt Mackie, *Amperion Conducts High-Voltage Broadband Test*, BROADBAND WIRELESS ONLINE, Dec. 5, 2003. If deployment on high-voltage wires proves feasible, it could dramatically expand the scope of BPL operations by reducing the need for fiber optic lines to connect BPL on distribution lines to the Internet and could also expand the utility benefits of BPL to the interstate transmission grid.

¹⁸ Current Technologies, Comments in ET Docket No. 03-104, 9 (July 7, 2003) [hereinafter Current Technologies Comments].

indirect evidence that BPL operators will have to directly compete on more basic considerations such as price, speed, reliability, and ease of use where it faces competition from other broadband systems.

2. Benefits for Utilities

BPL technology providers and electric utilities said BPL systems would benefit utility service by providing improved grid operation, such as:

i. Automated outage detection – many utilities still rely on calls from consumers in the final miles of power line distribution systems to homes to alert them to outages; automated outage detection could allow instant automatic notification and information down to level of problematic circuits.¹⁹

ii. Utility grid and equipment monitoring and control – similarly, BPL could facilitate extension of supervisory control and data acquisition (SCADA) systems, which currently monitor and control portion of electric system from the interstate high-voltage transmission wires to local transmission company substations, to be further extended from substations through medium-voltage distribution lines and into end user buildings.²⁰ This would allow utilities to analyze variations in power quality and take immediate corrective measures to protect sensitive equipment used by high technology manufacturing operations and other industries.²¹

iii. Automatic meter reading and electronic inspections – These functions would lower costs by allowing utilities to read meters and monitor end user equipment remotely and thereby avoid visits to customer premises and associated vehicle, labor and liability costs.²²

iv. Load management – This capability would foster better monitoring and control of the distribution network through load control/demand response, time of use rates, load profiling, meter theft monitoring, and remote stop/start.²³

Some electric utilities indicated that their primary interest in the technology at present is enhanced utility operations, a hopeful sign given the competitive challenges they will likely face in attempts to serve end users in many markets.²⁴ One utility noted that utility uses of BPL generally only consume small amounts of bandwidth, leaving significant bandwidth available for consumer applications.²⁵ The degree of such benefits is of critical importance to BPL's relative attractiveness. Unfortunately, the record was relatively devoid of quantifiable measures to be derived from such benefits. One outside study,

¹⁹ Cinergy Comments, *supra* note 15, at 4; Amperion Comments, *supra* note 15, at 9; PowerWAN, Comments in ET Docket No. 03-104, 5-6 (July 7, 2003)[hereinafter PowerWAN Comments]; Progress Energy, Comments in ET Docket No. 03-104, 9-10 (July 7, 2003) [hereinafter Progress Energy Comments].

²⁰ Cinergy Comments, *supra* note 15, at 3-4; Hawaiian Electric Company, Inc., Comments in ET Docket No. 03-104, 2 (July 2, 2003) [hereinafter Hawaiian Electric Comments]; PowerWAN Comments, *supra* note 19, at 6.

²¹ Southern Reply Comments, *supra* note 15 at 2-3.

²² Progress Energy Comments, *supra* note 19, 9 (July 7, 2003).

²³ PowerWAN Comments, *supra* note 19, at 6 n.3 (July 3, 2003).

²⁴ Hawaiian Electric Comments, *supra* note 20, at 1.

²⁵ Florida Power & Light Co., Comments in ET Docket No. 03-104, 6 (July 3, 2003)[hereinafter Florida Power Comments].

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however, estimated that a utility could garner \$28.5 million annually in utility function savings in a large market through deployment of an Access BPL system.²⁶

The Commission and the commenters also briefly discussed Power Line Carrier Systems (PLCS). PLCS, already deployed by many utilities, are low speed, low frequency power line communications carrier systems. They are not subject to the Commission's equipment authorization program or to most emissions rules applicable to carrier current systems, but rather operate on a non-interference basis as restricted low power transmitters covered under Part 15. These systems are, however, largely out of the scope of the main discussion because they operate on frequencies below 500 kHz and do not pose a comparable interference threat to other services as does BPL.

The Commission in the NOI said it believed that new high speed BPL technology could supplement PLCS and be used to assist the utilities by adding intelligent networking capabilities to the electric grid, allowing various interconnected and network addressable BPL components to work together in improving efficiency in activities such as energy management, power outage notification and automated meter reading.²⁷ One of the utilities indicated that the existing PLCS data transmissions are insufficient to implement advanced grid and outage control, and that control and monitoring will greatly benefit from introduction of BPL.²⁸

3. National Benefits

BPL proponents suggested a third category of benefits would be to national security as a whole. BPL technology provider and utility commenters cite BPL as a possible redundant data communications network in case of emergency harm to others networks.²⁹ They also noted that it could assist in implementing critical infrastructure industries under the Mission Essential Voluntary Assets ("MEVA") guidelines, which make utilities responsible to ensure secure infrastructure power for federal facilities, including military bases, and state, city, and local governments.³⁰ BPL in this respect could, for example, expand video surveillance of electric utility facilities.³¹

B. Modulation

The Commission inquired about the forms of modulation employed by BPL and their effect on the technology. Vendors indicated that standard

²⁶ United Telecom Council, Broadband Power Line Business Case Study, Final Report 148 (July 21, 2003). The study's primary author, David Shpigler, is a founder and co-owner of one BPL technology provider, Electric Broadband. See Electric Broadband, Comments in ET Docket No. 03-104, 2 (July 7, 2003) [hereinafter Electric Broadband Comments].

²⁷ BPL NOI, *supra* note 2, ¶ 28.

²⁸ Hawaiian Electric Comments, *supra* note 20, 2.

²⁹ Cinergy Comments, *supra* note 17, at 3; Current Technologies Comments, *supra* note 18, at 8-9.

³⁰ PowerWAN Comments, *supra* note 19, at 6; Hawaiian Electric Comments, *supra* note 20, at 2-3; Amperion Comments, *supra* note 15, at 9-10; Florida Power Comments, *supra* note 25, at 5.

³¹ PowerWAN Comments, *supra* note 21, at 7.

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broadband modulations were used, including Direct Sequence Spread Spectrum or Orthogonal Frequency Division Multiplexing for Access BPL.³² Different vendors use different modulation schemes, but commenters indicated that the particular modulation scheme used seems to have no effect on the ability of the system to comply with the FCC's Part 15 emissions limits.³³

C. Data Rates

With respect to data delivery speeds for Access BPL, utilities and BPL technology providers touted data rates equivalent to, or faster than, DSL and cable modem technologies, with rates ranging from 1- 3 Mbps for both uploads and downloads, though scientific evidence that such speeds were achieved was not provided.³⁴ This compares to cable modem rates of 1-3 Mbps for downloads and 128-500 Kbps for uploads and DSL rates of 144 Kbps to 9 Mbps for downloads and 128 Kbps to 1.5 Mbps for uploads.³⁵ A wide discrepancy in reported data speed delivery rates in part reflects BPL fundamental nature as a shared technology whose transmission rates depend upon the number of users at a given time. In-House speed estimates were estimated as being far faster, with data rates of 6.5 to 14 Mbps between outlets reported.³⁶

Not surprisingly, even faster rates are promised for next generation equipment, with speeds of up to 100 Mbps forecast.³⁷ Many electric utility and

³² Current Technologies Comments, *supra* note 18, at 5 n.3; UPLC Comments, *supra* note 6, at 5 n.12; Main.net Comments in ET Docket No. 03-104, 4 (July 7, 2003)[Hereinafter Main.net Comments].

³³ Southern, Comments in ET Docket No. 03-104, 13 (July 7, 2003)[hereinafter Southern Comments]

³⁴ Cinergy Comments, *supra* note 15, at 2 (stating that broadband access has reached speeds more than four times the speed of DSL during field tests); Ameren, Comments in ET Docket No. 03-104, 5 (July 7, 2003)[hereinafter Ameren Comments] (speeds are competitive with cable modem and DSL); Southern Reply Comments, *supra* note 15, at 9-10 (future data transmission rates could approach speeds twice as fast as the current generation of cable modems); Ambient, Comments in ET Docket No. 03-104, 3 (July 7, 2003)[hereinafter Ambient Comments](data rates of over 3 Mbps to the power outlets of homes); PowerWan Comments, *supra* note 19, at 2 (“greater than 1 MB/s per user is typically supported[for Access BPL]”; xG Technology, LLC, Comments in ET Docket No. 03-104, 3 (July 7, 2003)[hereinafter xGT Comments](speeds “closer to” 2-3 Mbps foreseen for Access BPL systems).

³⁵ Cable Modem vs. DSL: A Comparison, <http://web.mit.edu/is/help/network/comparechart.html> (last updated 4/30/03; visited October 24, 2003).

³⁶ PowerWAN Comments, *supra* note 19, at 2 (“6.5 Mb/s at the application layer”[for In-House BPL]; HomePlug Powerline Alliance, Comments in ET Docket No. 03-104, 2 (July 7, 2003)[hereinafter HomePlug Comments](In-House transmission of digital information at up to 14 Mbps between outlets).

³⁷ Southern Reply Comments, *supra* note 15, at 9 (future data transmission rates could approach speeds twice as fast as the current generation of cable modems). Even faster rates are promised for next generation equipment Main.net Comments, *supra* note 32, at 3 (100 Mbps potentially); PowerWAN Comments, *supra* note 19, at 2 (approximately 100 Mbps potentially; Progress Energy Comments, *supra* note 19, at 3 (54 Mbps potentially); HomePlug Comments, *supra* note 36, at 5 (Application layer throughput of more than 50 Mbps targeted for next-generation HomePlug AV standard).

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BPL Technology providers also maintained that Access BPL generally provides users with symmetrical bandwidth, unlike DSL and cable modem services.³⁸

D. Other Service Characteristics

BPL proponents were candid that the technology suffers from range limitations similar to DSL, with the current range of BPL limited to “substantially less than a mile.”³⁹ Others said rural transmission distances could exceed 1 to 2 miles based on measurements and possibly further with repeating. The difference in range metrics in part reflects the use of different frequencies, injection methods, and power. They also noted that fundamental differences apply to different BPL technologies that are being tested and deployed, which, as discussed *infra*,⁴⁰ will complicate the Commission’s attempts to apply common rules to BPL broadband delivery.

E. Spectrum and Bandwidth Needs

The Commission inquired regarding what spectrum and bandwidth Access BPL would use.⁴¹ The particular spectrum used by BPL has several consequences for the service. Higher frequencies would require the use of greater signal strength or more repeaters, two contributing factors to greater interference and greater cost. As noted below, the Commission’s RF emissions limits are tighter at higher frequencies. In addition, because BPL is a shared technology, the amount of bandwidth allocated to a particular data channel is a determinant of data transmission speed.⁴²

The Commission noted that in granting experimental licenses to some parties under 47 C.F.R. § 5 (2003) to evaluate access BPL equipment, the stated range allowed was from 1.7 to 80 MHz.⁴³ Such selection does avoid the AM and FM radio bands (0.54-1.7 MHz and 88-108 MHz, respectively). Unfortunately for BPL, other users, or both, however, those remaining bands are among the most heavily congested in the regulated spectrum, including VHF television channels.

A number of BPL technology providers indicated that spectrum used for Access BPL would include a large segment of that range, stating that commercial deployment of BPL will occur primarily between 1.7 MHz and 50 MHz.⁴⁴ Some

³⁸ PowerWAN Comments, *supra* note 19, at 2; Main.net Comments, *supra* note 32, at 4 (either symmetric or asymmetric); Progress Energy Comments, *supra* note 19, at 4; Ameren Comments, *supra* note 34, at 4.

³⁹ UPLC Comments, *supra* note 6, at 6. However, BPL proponents contend that it is limited to a distance from a network access point, a minimal amount of base equipment that is relatively easily installed, unlike the equipment intensive switching office of a local exchange carrier, which forms the reference point for DSL.

⁴⁰ See discussion *infra* at III(G).

⁴¹ BPL NOI, *supra* note 2, ¶ 15.

⁴² PowerWAN Comments, *supra* note 19, 2 (“If the whole band from 2-50 MHz is used, then the speeds should be in the range of 100 Mb/s”).

⁴³ BPN NOI, *supra* note 2, ¶ 15.

⁴⁴ See Southern Reply Comments, *supra* note 15, at 8; xGT Comments, *supra* note 34, at 3-4; Progress Energy Comments, *supra* note 19, at 2; Main.net Comments, *supra* note 32, at 4

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providers technology skewed lower.⁴⁵ Access BPL typically attempts to use the lowest frequencies available because lower frequency signals travel further and because of emission and cost concerns noted above.⁴⁶ On the other hand, one BPL technology provider predicted operation in bands as high as 88 MHz⁴⁷ and another requested approval of BPL operations as high as 200 MHz.⁴⁸ One provider contended that allowing service over a wide spectrum range would increase the value of the service by enabling frequency reuse and allow for frequency avoidance in particular situations.⁴⁹

Only one technology provider provided an estimate of a more limited *minimum* bandwidth that would be sufficient for Access BPL. BPL technology provider Ambient contended that BPL applications could not be optimized without a “seamless frequency range reaching at least 40 MHz.”⁵⁰ As can be seen by the above, this is little less than the wide band of frequencies requested by many of the adherents. In sum, the response to the Commission’s query on this point was disappointingly imprecise, particularly given that BPL participants’ business plans almost certainly contain sensitivity analysis on this point. While contending that spectrum should not be limited because of its unlicensed status as a Part 15 device, the electric utilities provided little strong evidence for a compelling fall-back position that would help the Commission determine an adequate spectrum bandwidth should interference prove so pervasive that such limitation was needed. In part, this may reflect usage pattern differences of different systems. Some systems, for example, use a wide bandwidth but have one device on at one time, while other designs use a large number of channels and dedicate channels capacity to different approaches, allowing less flexibility in bandwidth conservation. Interestingly, the Commission itself noted that some Access BPL equipment in Europe operates from 1.7 MHz to 10 MHz.⁵¹

Commenters said that In-House BPL would likely operate in a more limited 4.5 MHz to 21 MHz range.⁵²

F. Deployment Plans

The Commission inquired about deployment plans regarding Access BPL, which has been criticized by many as a perennial “just around the corner”

(equipment operates at 2-30 MHz); Amperion Comments, *supra* note 15, at 4; PowerWan Comments, *supra* note 19, at 1.

⁴⁵ xGT Comments, *supra* note 34, at 3-4 (system works with Access and In-House BPL devices operating from 100 KHz to 30 MHz with operations on carrier frequencies above 30 MHz not necessary unless high data rates are required).

⁴⁶ Electric Broadband Comments, *supra* note 26, at 4 (“BPL is part of a hybrid fiber – BPL network. The shorter the BPL component, the further the fiber has to extend into the neighborhood to provide service.”).

⁴⁷ Current Technologies Comments, *supra* note 18, at 17.

⁴⁸ Satius, Inc., Comments in ET Docket No. 03-104, 5 (July 14, 2003) [hereinafter Satius Comments].

⁴⁹ PowerWAN Comments, *supra* note 19, at 1.

⁵⁰ Ambient Comments, *supra* note 34, at 10.

⁵¹ BPL NOI, *supra* note 2, ¶ 15 n. 25.

⁵² PSWN Comments, *supra* note 15, at 3.

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technology. One BPL industry group was candid about the technology's past record of dashed hopes and technical tribulations. The United Power Line Council (UPLC) noted that the United Telecom Council Power Line Telecommunications Forum in 1999 was "skeptical towards the future of BPL in North America" and outlined five principle obstacles to its deployment:

"At that time, the electric noise on the lines, the high number of transformers⁵³ on the electric grid, insufficient capacity, interference and safety issues all led to the conclusion that BPL could not compete technically or economically with incumbent broadband technologies, such as cable modem, DSL and satellite."⁵⁴

BPL proponents indicated that mechanisms for addressing such concerns, most notably by bypassing transformers, have mitigated these concerns.⁵⁵ Regarding deployment, proponents generally indicated that the technology was not immediately ready for deployment to the public but would be ready in the 2004-05 time-frame.⁵⁶ Utilities generally indicated that they were still in the process of conducting field and market trials of Access BPL.⁵⁷ Access BPL equipment includes the injector, the interface between the network access connection and a feeder to the medium voltage power line; the extractor, the device that connects the BPL network to the bandwidth destination; and the repeater extractor, a signal amplifier on the medium voltage line.⁵⁸

Subsequent to the reply comments, some utilities released additional commercial rollout plans at the United Power Line Council's annual conference in late September 2003. The City of Manassas, Virginia, voted October 16, 2003 to grant a 10-year franchise to Prospect Street Broadband to expand a BPL field trial and offer high-speed Internet service to the entire community over municipal power lines.⁵⁹ Cinergy, in a joint venture with BPL technology provider Current Technologies, said it would start commercial deployment in its utility service area in Fourth Quarter 2003, with a rollout in Ohio in the fourth quarter and expansion into Indiana and Kentucky in 2004 with a target to pass 250,000 homes in three

⁵³ Transformers are devices composed of electric coils of wire used near residences to reduce the voltage of electric current flowing to end users.

⁵⁴ UPLC Comments, *supra* note 6, at 2.

⁵⁵ *Id.*

⁵⁶ "The record also reveals that BPL is not quite ready for deployment to the general public." Southern Reply Comments, *supra* note 15, at 10. "The multi-phase testing process suggests that deployment of a commercial service by utilities will occur in the 2004-2005 timeframe." *Id.* at 11; PowerWAN Comments, *supra* note 19, at 2 (expecting to deploy Access BPL equipment in 2004).

⁵⁷ See UPLC Comments, *supra* note 6, at 2 (noting that nine trials were currently underway with utilities); PPL Comments, *supra* note 15, at 2 (conducting a trial with Main.net); Hawaiian Comments, *supra* note 20, at 1 (conducting a trial with Intellon Corporation); Cinergy Comments, *supra* note 15, at 1-2 (conducting a trial with Current Technologies); Progress Energy Comments, *supra* note 19, at 1-2, 4 (conducting a trial with Amperion).

⁵⁸ See Amperion Comments, *supra* note 15, at 2-3.

⁵⁹ Sari Kreiger, *Innovative Web access to shock Manassas*, MANASSAS JOURNAL MESSENGER, Oct. 18, 2003. Tentative service price is \$29.95 for residents, and \$69.95 for commercial access, with service expected to become available within 120 days of the contract's signing. *Id.*

years in southwest Ohio.⁶⁰ IdaComm said it was considering a January 1, 2004 commercial deployment date through its Ohio Power utility subsidiary and PPL Telecom announced that it would decide on a commercial rollout in November 2003.⁶¹ However, in December news reports indicated that only the City of Manassas, Virginia was prepared for commercial rollout under the time frame it had earlier stated.⁶²

While at last offering some Access BPL commercial deployment dates, most electric utilities remain tentative regarding making major outlays of money and commitment of limited employee resources for, and association of their valuable brand names with, the deployment of BPL. Certainly, there is no investment equivalent to the more than \$55 billion invested by the cable industry from 1996 to 2002⁶³ to upgrade plant to allow the rollout of digital services, including cable modem broadband delivery, to subscribers, nor even to the more modest efforts by incumbent local exchange carriers to offer DSL broadband to an expanded base of customers.⁶⁴

In-House BPL equipment manufacturers noted that they have placed a wide variety of commercial In-House BPL equipment on the market. A total of 17 companies manufacture 58 different products that comply with the HomePlug In-House BPL standard.⁶⁵ Such devices include Powerline cable/DSL routers, and gateway devices that include Powerline + DSL and Powerline + cable modems.⁶⁶

G. Standards

A key issue in facilitating adoption of BPL and a common approach toward interference concerns is the adoption of standards. The Commission inquired regarding what standards work had been performed both domestically and internationally on Access BPL and the results of such activities.⁶⁷

⁶⁰ Dinesh Kumar, *Utilities unveil time lines for commercial broadband deployment*, COMMUNICATIONS DAILY, Sept. 23, 2003 (quoting Cinergy Executive Vice President William Grealis).

⁶¹ *Id.* (quoting IdaComm Chief Executive Officer Chris Britton and PPL Telecom Director of Strategic Planning Timothy Sweeney). PPL Telecom is a subsidiary of Allentown, Pennsylvania-based energy holding company PPL Corp. PPL Comments, *supra* note 15, at 1, respectively.

⁶² Dinesh Kumar, *Utilities Revise Broadband-Over-Power-Line Rollout Schedules*, COMMUNICATIONS DAILY, Dec. 9, 2003. Cinergy said that it would commence commercial service in the first quarter of 2004 and IdaComm announced it was delaying its January rollout schedule to at least Summer of 2004, when a decision on a commercial launch would be made. *Id.* Manassas said that it would sign up its first customers in December 2003. *Id.*

⁶³ Robert Sachs, President and CEO, National Cable & Telecommunications Association, Samuel Morse Did Not Invent the Telegraph, Remarks to NAB Futures Conference, Pebble Beach, California, March 19, 2002.

⁶⁴ SBC Communications, for example, in 1999 launched a \$6 billion program, Project Pronto, to expand DSL availability, though this program was subsequently scaled back. *See, e.g.,* Vikas Bajaj, *SBC takes its case to the states; uncertain of Congress' backing, firm tries another tack*, The Dallas Morning News, March 18, 2002, at 1D.

⁶⁵ Intellon Corp., Comments in ET Docket No. 03-104, 5 (July 7, 2003)[hereinafter Intellon Comments].

⁶⁶ HomePlug Powerline Alliance, Reply Comments in ET Docket No. 03-104, 4 (Aug. 20, 2003).

⁶⁷ BPL NOI, *supra* note 2, ¶ 15.

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Commenters noted that Access BPL providers employ a host of different delivery mechanisms with different engineering standards to deliver communications signals to users, a sign of thriving innovation or lack of consensus, depending upon how this is viewed. As industry experts have noted, standardization is complicated by at least four distinct delivery mechanisms:⁶⁸

- i. A "classic" style, representing the most typical design, with medium voltage (MV) and low voltage (LV) technology that originates at the utility substation and reaches the end customer via BPL.
- ii. A cellular design involving deploying backhaul elements into the field closer to the end customer.
- iii. A powerline/wireless hybrid approach that leverages Wi-Fi⁶⁹ wireless technology for the last mile while using BPL on the MV grid.
- iv. A low voltage design that features an injection of the BPL signal on the secondary side of the transformer .

Nonetheless, some groups are working to develop standards. The Commission noted that the IEC CISPR Subcommittee I Interference Relating to Multimedia Equipment, Working Group 3 on Emission from Information Technology Equipment, is developing conducted emission limits for new BPL technologies.⁷⁰ A technical committee of the United Telecom Power Line Council is working to achieve voluntary standardization that would allow interoperability between BPL systems⁷¹

The Commission has already steered toward a more international approach through its harmonization of domestic requirements for some Part 15 equipment with international standards developed by the International ElectroTechnical Commission International Special Committee on Radio Interference for limits on RF energy permitted to be conducted onto AC lines.⁷² The Commission in that proceeding, however, explicitly deferred limits and measurement procedures applicable for Carrier Current Systems to a future proceeding.⁷³

The Commission asked similar questions with respect to In-House BPL. The Commission noted that there are several operational standards for In-House power line applications, as referenced in ANSI TIA/EIA 600.31 Power Line Physical Layer and Medium Specifications and ANSI TIA/EIA 709.2 Control Network Power Line (PL) Channel Specification.⁷⁴ A leading standard, as noted above, is HomePlug Alliance's 1.0 standard, based on Intellon and Cogency chip sets.

⁶⁸ United Telecom Council, Broadband Power Line Business Case Study, Final Report 2 (July 21, 2003).

⁶⁹ Wi-Fi is a wireless local area network technology, Standard 802.11b, operating at the 2.4 GHz frequency band and offering data rates of 5-6 Mbps. *Id.* at 31.

⁷⁰ BPL NOI, *supra* note 2, ¶ 15.

⁷¹ *Manassas (Va.) set to roll out Broadband over Power Line*, WASHINGTON INTERNET DAILY, Aug. 27, 2003.

⁷² See Report and Order, In the Matter of 1998 Biennial Regulatory Review – Conducted Emissions Limits Below 30 MHz for Equipment Regulated Under Parts 15 and 18 of the Commission's Rules, 17 F.C.C.R. 10806 (2002)[Hereinafter Conducted Emissions Limits Order].

⁷³ *Id.* ¶ 2.

⁷⁴ BPL NOI, *supra* note 2, ¶ 17, 17 n.26.

The Commission also noted that the Consumer Electronics Association has a working group on power line standards, other individual companies are designing and marketing their own PLC chip sets for sale to PLC device vendors,⁷⁵ and that several consortiums are promoting In-House BPL technology and its applications.⁷⁶

H. Summary

In sum, the commenters, and additional marketplace information, paints an image of an industry that may be able to present a credible Internet broadband delivery mechanism, with the particular benefit of furthering the development of a more intelligent electric grid. Standards and basics of system performance remain a matter for debate, though development for In-House BPL is markedly more advanced. Commitment to commercial deployment, while finally greenlighted by some utilities, are generally limited to modest rollouts.

IV. How Great Are Interference Concerns

A. The Commission's Existing Interference Regulations

As noted, the primary immediate regulatory area of concern to the Commission is the possible impact of RF interference caused by BPL systems to other licensed and unlicensed users of spectrum regulated by the Commission.

Interference⁷⁷ includes radiated emissions, wave emissions that radiate outwards from a source and interfere with its performance (such as sound waves from rotating appliances like vacuum cleaners colliding with and compromising signals subsequently received by television set receivers), and conducted emissions, wavelengths that travel along wiring or another conducting medium and interrupt its performance (such as an electrical charge introduced by a frayed wire onto a television set cord and thereby into the set itself, where it collides with, and degrades, the received signal).

Three classes of interference were cited by the Commission as a matter of concern:⁷⁸

⁷⁵ *Id.* ¶ 17 n.27 (citing applications advertised at nSine, <http://www.nsine.com/>; EasyPlug, <http://www.easyplug.com/>; Itran, <http://www.itrncomm.com/>; Enikia, <http://www.enikia.com/>; DS2, <http://cgi.ds2.es/>; and Phonex Broadband Corporation, <http://www.phonex.com/>).

⁷⁶ BPL NOI, *supra* note 2, ¶ 17 n.28 (citing In-House BPL consortiums including the Consumer Electronics Association, the EchoNet Consortium, the HomePlug Alliance, and the European PLCForum Association).

⁷⁷ “Interference” is defined as follows, according to the Commission’s rules: “The effect of unwanted energy due to one or a combination of emissions, radiations, or inductions upon reception in a radio-communication system, manifested by any performance degradation, misinterpretation, or loss of information which could be extracted in the absence of such unwanted energy.” 47 C.F.R. § 2.1 (2003). “Harmful interference” is defined as follows: “Interference which endangers the functioning of a radio navigation service or other safety services or seriously degrades, obstructs, or repeatedly interrupts a radio communication service operating in accordance with these [international] Radio Regulations.” *Id.*

⁷⁸ See BPL NOI, *supra* note 2, ¶¶ 18-19.

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1. In the spectrum below 30 MHz, incumbent authorized operations include fixed, land mobile, aeronautical mobile, maritime mobile, radiolocation, broadcast radio, amateur radio terrestrial and satellite, and radio astronomy. Radiated emissions concerns is particularly great in these bands because, as the Commission noted in an earlier proceeding, at such frequencies, where wavelengths are greater than 10 meters, long stretches of electrical wiring act as efficient antennas, and signals radiating onto the airwaves can cause interference to operations at considerable distances because propagation losses are low at these frequencies.⁷⁹

2. In the spectrum from 30 to 300 MHz, incumbent authorized operations include fixed land mobile, aeronautical mobile, maritime mobile and mobile satellite, radio astronomy, amateur radio terrestrial and satellite, broadcast TV and radio, public safety and law enforcement, federal government aeronautical radio navigation, radio navigation satellite and radiolocation.

3. A third class of potentially affected parties are other utilities and cable operators with communications wires and equipment collocated on utility poles and in conduits.

BPL systems are “carrier current systems” (CCS), which are defined as a system, or part of a system, that transmits radio frequency energy by conduction over the electric power line to a receiver also connected to the same power line.⁸⁰ Such devices include AM campus radio stations, intercom systems, and remote controls for electronics appliances and lamps.⁸¹

Part 15 of the Commission’s rules permits operation of low power RF devices without a license from the Commission or the need for frequency coordination. Under Part 15, unlicensed operators must accept whatever interference is received and must correct whatever harmful interference is caused, including ceasing operation of the Part 15 system causing the interference.⁸² Manufacturers of CCS equipment must comply with a verification procedure for equipment used.⁸³

While the rights of Part 15 operators are generally subordinate to those of licensed spectrum users, the Commission and the D.C. Circuit have upheld the rights of Part 15-authorized users compliant with the Part 15 regulations against spectrum licensees arguments that they had received exclusive licenses and could

⁷⁹ Notice of Inquiry, In the Matter of 1998 Biennial Regulatory Review – Conducted Emissions Limits Below 30 MHz for Equipment Regulated Under Parts 15 and 18 of the Commission’s Rules, 13 F.C.C.R. 12955, ¶ 3 (1998)[hereinafter Conducted Emissions Limits NOI].

⁸⁰ See 47 C.F.R. § 15.3(f) (2003).

⁸¹ BPL NOI, *supra* note 4, ¶ 4.

⁸² 47 C.F.R. § 15.5 (2003).

⁸³ See 47 C.F.R. § 2.902 (2003).

therefore exclude non-interfering Part 15 devices from their licensed frequencies. In the Commission's proceeding that developed rules for ultra-wideband systems operating under Part 15, for example, the Commission rejected Personal Communications System (PCS) industry arguments that it had erred in failing to limit further UWB expansion by holding PCS licenses could not be used to exclude UWB devices not causing harmful interference.⁸⁴ The DC Circuit has held that even exclusive licensees cannot object to secondary use of spectrum so long as no harmful interference results and that exclusivity for licensees is only against other licensees.⁸⁵

The Commission's Part 15 interference standards are designed principally to control interference from a user's device to other users of the spectrum, "e.g., from a user's personal computer to a neighbor's AM broadcast reception," and are generally less directed at controlling interference between devices within a user's immediate premises, "from the user's personal computer to an AM broadcast receiver sitting on the same desk and connected to the same electrical outlet."⁸⁶

1. Emissions Limits

Compliance with Commission emissions limits represents the primary responsibility of operators of Part 15 devices. The Commission's emissions limits serve as a maximum for emissions of unlicensed devices. Importantly, however, if Part 15 devices meet the Rules' limits yet still cause harmful interference, they are required to cease operation.⁸⁷ The Commission's rules divide regulation of CCS into devices above and below 30 MHz.

a. CCS Devices at or below 30 MHz

For CCS operating at or below 30 MHz (down to 9 kHz), the Commission imposes a limit on *radiated* emissions from any part of the wiring or power network connected to the RF power source.⁸⁸ The radiated emissions limits, which vary with frequency, apply from 9 kHz to an upper frequency that is dependent on the highest fundamental frequency of the device under the test.⁸⁹ A standard measure is the limit of 30 V/m at a distance of 30 meters over the frequency range from 1.705 to 30 MHz.⁹⁰ The Commission's examination of

⁸⁴ First Report and Order, In the matter of Revision of Part 15 of the Commission's Rules Regarding Ultra-Wideband Transmission Systems, 17 F.C.C.R. 7435, ¶ 271(2002)[Hereinafter UWB First R&O], *modified by*, Memorandum Opinion and Order and Further Notice of Proposed Rule Making, 18 F.C.C.R. 3857 (March 12, 2003)[hereinafter UWB MO&O/FNPR] ("This spectrum is not, and has never been, exclusive to Sprint or to any other licensee or user").

⁸⁵ AT&T Wireless Services, Inc. v. FCC, 270 F.3d 959, 964 (D.C. Cir. 2001).

⁸⁶ Conducted Emissions Limits Order, *supra* note 72, ¶ 17.

⁸⁷ See 47 C.F.R. § 15.15(c) (2003).

⁸⁸ BPL NOI, *supra* note 2, ¶ 11 (citing 47 C.F.R. § 15.109(e) (2003)).

⁸⁹ *Id.* (citing 47 C.F.R. §§ 15.109(e), 15.209(a) and 15.33(b)(2) (Section 15.109(e) incorporates Section 15.209(a) by reference). If, for example, the highest frequency generated or used in the device, or on which the device operates or tunes is 10 MHz, the upper frequency to be examined is 500 MHz. *Id.* at 5 n.16.

⁹⁰ *Id.*

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interference issues includes examination of possible interference at the harmonics of the operating frequency in question.⁹¹

In addition, *conducted* emissions limits apply to a narrow range of CCS applications below 30 MHz. For carrier current systems that contain their fundamental emission with the standard AM broadcast band of 535 to 1705 kHz and are intended to be received using standard AM broadcast receivers, there is no limit on conducted emissions, while all other CCS operating below 30 MHz are subject to a conducted emissions limit only within the AM broadcast band (535 to 1705 kHz).⁹² Low frequency power line carrier systems, the low frequency, widely deployed utility communications systems, are subject to a separate set of minimal rules.⁹³ The FCC recently reexamined its conducted emissions limits and their applicability to carrier current systems.⁹⁴

b. CCS Devices at or above 30 MHz

Above 30 MHz, regulation is more stringent, as the radiation efficiency of devices at higher frequencies is greater. Part 15 digital devices, including CCS, operating as general intentional and unintentional radiators⁹⁵ above 30 MHz are subject to both radiated emission limits and conducted emission limits. The limits apply from 30 MHz to an upper frequency that is dependent on the highest fundamental frequency of the device under test.⁹⁶

Radiated limits for digital devices like BPL equipment are separated into limits for Class A devices,⁹⁷ devices marketed for use in a commercial, industrial or business environment, excluding devices for use by the general public or intended to be used in a home,⁹⁸ and for Class B devices,⁹⁹ marketed for use in a residential environment, notwithstanding use in commercial, business and industrial environments.¹⁰⁰

⁹¹ Harmonics are signals from a transmitter or oscillator occurring at multiples of the desired operating frequency. If, for example, the highest frequency generated or used in the device, or on which the device operates or tunes is 10 MHz, the upper frequency to be examined is 500 MHz. BPL NOI, *supra* note 2, ¶11 n.16.

⁹² *Id.* (citing 47 C.F.R. §§ 15.107(c)(2) and 15.221. This provision does not apply to power line carrier systems.

⁹³ 47 C.F.R. § 15.113 (2003).

⁹⁴ See Conducted Emissions Limits NOI, *supra* note 79; Notice of Proposed Rule Making, In the Matter of 1998 Biennial Regulatory Review – Conducted Emissions Limits Below 30 MHz for Equipment Regulated Under Parts 15 and 18 of the Commission's Rules, 14 F.C.C.R. 18180 (1999)[hereinafter Conducted Emissions Limits NPRM]; Conducted Emissions Limits Order, *supra* note 72.

⁹⁵ An intentional radiator is defined as a device that intentionally generates and emits radio frequency energy by radiation or induction. 47 C.F.R. § 15.3(o) (2003). An unintentional radiator is defined as a device that intentionally generates radio frequency energy for use within the device, or that sends radio frequency signals by conduction to associated equipment via connecting wiring, but which is not intended to emit RF energy by radiation or induction. 47 C.F.R. § 15.3(z) (2003).

⁹⁶ BPL NOI, *supra* note 2, ¶ 11 (citing 47 C.F.R. §§ 15.33(b)(1) (2003)).

⁹⁷ 47 C.F.R. §§ 15.109(b) (2003)(90 μ V/m measured at 10 meters).

⁹⁸ 47 C.F.R. §15.3(h) (2003).

⁹⁹ 47 C.F.R. §§ 15.109(a)(2003)(100 μ V/m measured at 3 meters).

¹⁰⁰ 47 C.F.R. § 15.3(i) (2003).

Digital devices operating above 30 MHz are also subject to either Class A¹⁰¹ or Class B¹⁰² *conducted* emissions limits, depending on their operating environment, if they receive power from the power line.¹⁰³

2. Equipment Authorization

Compliance with Commission equipment authorization rules is the primary responsibility of manufacturers of Part 15 devices. Section 302 of Communications Act of 1934, as amended, authorizes the Commission to make reasonable regulations, consistent with the public interest, governing the interference potential of equipment that emits radio frequency energy.¹⁰⁴

The Commission carries out its responsibilities under Section 302 by establishing technical regulations for transmitters and other equipment to minimize their potential for causing interference to radio services, and by administering an authorization program to ensure that equipment reaching the market complies with the technical requirements.¹⁰⁵

The authorization program requires that the equipment be tested either by the manufacturer or at an independent test laboratory to ensure that it complies with the technical requirements.¹⁰⁶ The authorization program specifies several procedures for demonstrating equipment compliance. The procedure to which a device is subject depends on the risk of interference the equipment poses to licensed radio services.

There are three alternate procedures:

i. Certification, the most rigorous, results in an equipment authorization issued by the Commission or designated entities based on representations and test data submitted by the applicant.¹⁰⁷

ii. Declaration of conformity, the second most rigorous, involves a manufacturers self-approval procedure where responsible, accredited party makes measurements or takes other necessary steps to ensure that the equipment complies with the appropriate technical standards.¹⁰⁸

iii. Verification, the least rigorous procedure, is a manufacturer's self-approval procedure involving manufacturer measurements or implementation steps to ensure that the equipment complies with appropriate technical standards. Unlike declaration of conformity, however, verification does not require the use of an accredited laboratory and does not require that a declaration of conformity be supplied with equipment.¹⁰⁹

Currently, CCS equipment is subject exclusively to verification. The Commission noted that while it has found the verification procedure adequate to ensure that existing CCS devices comply with its rules, "BPL technology could

¹⁰¹ See 47 C.F.R. § 15.107(b) (2003).

¹⁰² See 47 C.F.R. § 15.107(a) (2003).

¹⁰³ BPL NOI, *supra* note 2, ¶ 11.

¹⁰⁴ 47 U.S.C. § 302a (2003).

¹⁰⁵ BPL NOI, *supra* note 2, ¶ 24.

¹⁰⁶ *Id.*

¹⁰⁷ *Id.* ¶ 25. See 47 C.F.R. § 2.907 (2003).

¹⁰⁸ 47 C.F.R. § 2.906 (2003).

¹⁰⁹ 47 C.F.R. § 2.902 (2003).

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post increased risk of harmful interference, and thus new BPL devices may need a higher degree of oversight to ensure that authorized users are not subject to interference.”¹¹⁰

B. The Fundamental BPL Interference Issues

Interference has been an area of acute policy and enforcement concern for the Commission. Interference protection was cited by participants in the Commission's recent spectrum policy reform proceeding as “the prime example of rules that are not clearly defined. A common refrain was that the FCC rules speak for the right to be protected from ‘harmful interference,’ but this term is not defined in technical terms, making objective measurement difficult.”¹¹¹

The high level of concerns related to BPL interference, primarily Access BPL interference, relates to what spectrum licensees contend is its pervasiveness, in several different respects. As noted by amateur radio commenters, the current compatibility of Part 15 devices is predicated on the device being an identified point-source of radiation, operating on discrete frequencies and operating intermittently.¹¹² By contrast, the radio amateurs contend, “BPL transmits over a large geographical area, radiates on broad bandwidth of frequencies, and operates continuously.”¹¹³ BPL technology providers contend that such assertions are premised in a faulty understanding of BPL technology.

Underlying the disputes between the spectrum users and the BPL providers in the proceeding are several fundamental disputes regarding BPL interference characteristics.

The first is whether an entire Access BPL system will radiate energy like a single large antenna, as the amateur radio operators contend, or whether interference emissions points will be limited to discrete points near BPL equipment widely spread throughout the BPL systems.

The amateur radio opponents to BPL contend that because electromagnetic fields associated with transmission lines do not completely cancel, significant radiation will occur across the entire length of RF energized electric power transmission lines.¹¹⁴ The Commission itself noted in the NOI that “at frequencies below 30 MHz, where wavelengths exceed 10 meters, long stretches of electrical wiring can act as an antenna, permitting the RF energy to be radiated over the airwaves.”¹¹⁵

Utility and BPL technology provider commenters contend that that assertion is erroneous and that BPL emissions come almost entirely from a short

¹¹⁰ BPL NOI, *supra* note 2, ¶ 26.

¹¹¹ FCC, SPECTRUM POLICY TASK FORCE REPORT 18 (ET Docket No. 02-135) (Nov. 2002), available at http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-2285542A1.pdf. [HEREINAFTER SPECTRUM POLICY REPORT]

¹¹² National Association for Amateur Radio, Comments in ET Docket No. 03-104, 12 (July 7, 2003) [hereinafter ARRL Comments]

¹¹³ Academy of Model Aeronautics, Reply Comments in ET Docket No. 03-104, 3 (Aug. 18, 2003)[hereinafter AMA Reply Comments].

¹¹⁴ Michael C. Tope, Reply Comments to the Comments of Current Technologies, LLC in ET Docket No. 03-104, 7 (Aug. 18, 2003)[hereinafter Tope Reply Comments].

¹¹⁵ BPL NOI, *supra* note 2, ¶ 5.

segment of line immediately adjacent to where the BPL device is attached and that BPL emissions therefore from as close as a few meters away resembles point source emitters such as computers and household appliances.¹¹⁶

The second major issue of contention is whether BPL equipment elements will aggregate interference at a vast number of points, as the amateur radio operators contend, or will alternate as emissions points with only one unit operational at a time, producing a vastly lesser amount of RF interference at any point in time.

The National Association for Amateur Radio, also known as the American Radio Relay League (ARRL), stated that Part 15 radiated emission limits presume the deployment of point-source radiators with localized interference potential and that the rules were not intended to deal with multiple transmitter or radiating distribution systems operating over large geographic areas.¹¹⁷

Southern countered that the wide variety of communications devices introduced in many frequency bands under the rules, such as cordless telephones, baby monitors, wireless intercoms, wireless microphones, “there has been no evidence that licensed services in the same frequency bands have been rendered useless.”¹¹⁸ Southern added, “It is also extremely unlikely that the number of active, simultaneous transmissions in a given cell will approach anywhere near the level ARRL fears.”¹¹⁹ Current Technologies said that even though an Access BPL system will have one medium-voltage device at each transformer, only one of those on a distribution leg can transmit at a time and that, therefore, no harmful aggregation of BPL signals can result.¹²⁰ Amateur radio enthusiasts contend, nonetheless, that “at very high levels of deployment (e.g., 100 simultaneous BPL sources per square mile across a large metropolitan area), the potential for aggregation becomes very real.”¹²¹

What is remarkable is the disparity between the sides as to the magnitude of interference effects, with BPL technology providers contending such effects will be minimal¹²² and spectrum users contending they will be enormous.¹²³

Another key issue is the degree to which Access BPL equipment would undermine the traditional role of transformers as a barrier to interference with respect to interference originating both on power lines and in homes. The Commission asked if there are interference effects on other houses or apartments sharing same local low voltage distribution by the RF signal on low voltage side of the transformer. To date, the transformer has acted as an efficient barrier between RF on medium-frequency power lines on one side of the transformer,

¹¹⁶ Comments of Current Technologies, *supra* note 18, at 14.

¹¹⁷ ARRL Comments, *supra* note 112, at 12.

¹¹⁸ Southern Reply Comments, *supra* note 15, at 17-18.

¹¹⁹ *Id.* at 18.

¹²⁰ Current Technologies Comments, *supra* note 18, at 14-15.

¹²¹ Tope Reply Comments, *supra* note 114, at 9-10.

¹²² See Main.net Communications Ltd., Reply Comments in ET Docket No. 03-104, 2 (Aug. 20, 2003)[Hereinafter Main.net Reply Comments] (“provision of BPL communications under the Commission’s rules cause only benign interference to other communications services.”).

¹²³ ARRL Comments, *supra* note 112, at 22 (“BPL is . . . a Pandora’s Box of unprecedented proportions.”)

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and low frequency lines to individual homes on the other. Many BPL Access technologies rely on coupling devices to bypass the transformer, which would otherwise block the signal. By doing so, they also bypass the interference protection provided by the transformer, a number of commenters noted.

ARRL said that use of high pass filters to bypass transformer will couple all RF noise generating device in every building onto the line as well, increasing interference of in house devices.¹²⁴ ARRL criticized many assertions by power companies and alleged that Ambient Corp. misreported antenna gain.¹²⁵ One BPL technology, PowerWAN, suggested that even without such bypasses, transformers cannot be relied upon to isolate frequencies and reduce interference between in-House and Access BPL technologies.¹²⁶ PowerWAN instead said that balanced signal injections using different methods reduces radiation emissions concerns. PowerWAN also said that definition of frequency bands to be avoided or that have signal attenuation would help.¹²⁷

C. Interference to Different Categories of Users

A wide variety of RF spectrum users commented on the possible impact of BPL upon their use of spectrum. The following subsections describe the concerns they expressed by different categories of commenters.

1. Amateur Radio

ARRL claimed that power line interference is already a leading cause of interference problems for its members: "Power line noise is the single most frequently identified source of HF¹²⁸ interference to licensed Amateur Radio operators."¹²⁹ ARRL said that in 2002 and 2003 "to date," 245 interference complaints were reported by ARRL members to ARRL,¹³⁰ with 40 of those 245 cases eventually being referred to Commission's Enforcement Bureau for resolution.¹³¹ ARRL said that the Commission's Enforcement Bureau has sent out letters to 23 different utilities about power line interference problems during 2002 and 2003 in cases where the radio amateur has not been able to obtain cooperation from the utility company involved.¹³² It should be noted, however, that this form of noise is distinct from that which will be posed by BPL.

ARRL contended that BPL cannot operate in bands also used by amateur radio licensees (2 to 80 MHz) without generating unacceptable levels of interference. "This interference potential, as matter of both law and fact,

¹²⁴ *Id.* at 8.

¹²⁵ National Association for Amateur Radio, Reply Comments in ET Docket No. 03-104, 15 (Aug. 20, 2003)[hereinafter ARRL Reply Comments].

¹²⁶ PowerWAN Comments, *supra* note 19, at 3.

¹²⁷ *Id.*

¹²⁸ ARRL Comments, *supra* note 112, at 3. Frequency bands potentially affected by BPL include Medium Frequency (0.3-3.0 MHz), the High Frequency band (3-30 MHz) and the lower Very High Frequency (30-300 MHz).

¹²⁹ *Id.* at 3.

¹³⁰ *Id.*

¹³¹ *Id.* at 4.

¹³² *Id.*

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disqualifies access BPL as a potential future competitive broadband delivery system” because noise from electric power lines is a source of interference to extremely sensitive receivers used by some amateur radio enthusiasts.¹³³

Ambient countered that noisy power lines are often caused by faulty insulators, surge arrestors or other devices associated with power lines and that such errors can better be detected (and thereafter replaced) through the installation of BPL systems.¹³⁴

ARRL said that there are interference issues with some In-House BPL equipment,¹³⁵ but indicated that the HomePlug devices were far less problematic to the amateur radio broadcasters than Access BPL systems.¹³⁶ ARRL said it has worked with HomePlug consortium to avoid interference problems and that HomePlug agreed to notching in product specifications to remove amateur bands from operating frequencies of such systems.¹³⁷ ARRL said that while there is still some interference from devices using HomePlug standard, the “number of complaints from these systems today is relatively small.”¹³⁸

Amateur radio satellite operators also contended that downlinks and uplinks from their satellites would be jeopardized by the cumulative effects of multiple BPL systems.¹³⁹

However, the Amateur Radio Research and Development Corporation (AMRAD) said that its testing at a Potomac Maryland BPL test installation avoided the radio amateur allocated band with the exception of the new 5 MHz frequencies, as well as the 9 and 11 MHz bands, which correspond to international shortwave.¹⁴⁰

Amateur radio operators also expressed concern that their broadcasts could interfere with functioning of BPL devices, including In-House BPL devices. They said that this was a matter of concern despite BPL’s lack of protection under the rules given that any interference conflicts could pit a relatively small number of radio hobbyists against a far larger, and more politically powerful number of BPL subscribers. Testing by AMRAD at a single location showed a high level of susceptibility of HomePlug standard devices to amateur radio signals, with an amateur radio station on the 20 meter band inducing a loss of 87% of the data packets in a system using the Homeplug standard at a transmitter power of 10 watts.¹⁴¹

¹³³ *Id.* at 2.

¹³⁴ Ambient Comments, *supra* note 34, at 9.

¹³⁵ ARRL claimed interference by Phonex Model PX-421 wireless modem jack to AR. Details at www.arrl.org/tis/info/rfiteljx.html> ARRL Reply Comments, *supra* note 125, at 12.

¹³⁶ ARRL Comments, *supra* note 112, at 4-5.

¹³⁷ *Id.* at 5.

¹³⁸ *Id.*

¹³⁹ Radio Amateur Satellite Corporation, Comments in ET Docket No. 03-104, 3-4 (July 7, 2003).

¹⁴⁰ Amateur Radio Research and Development Corp., Comments in ET Docket No. 03-104, 2 (July 7, 2003)[Hereinafter AMRAD Comments].

¹⁴¹ Amateur Radio Research and Development Corp., Reply Comments in ET Docket No. 03-104, 3-4 (Aug. 20, 2003)[Hereinafter AMRAD Reply Comments].

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2. Shortwave Radio

The North American Shortwave Association (NASWA) and the National Association of Shortwave Broadcasters (NASB) objected to BPL because of concerns that it could interfere with reception in the United States of shortwave broadcasts originating in other countries. Use of the 2 to 30 MHz bands by BPL would be “catastrophic to the current users of this spectrum.”¹⁴²

NASB questioned the accuracy of ARRL's conclusions that notching by In-House BPL providers could acceptably reduce interference, finding that such notching would constrain future changes or adjustments in spectrum to accommodate future conditions or needs.¹⁴³

Southern in its reply comments responded that there are limits to which BPL can be expected to avoid shortwave signals, given that shortwave signals that arrive here are weak to begin with given distances traveled and also are subject to seasonal variations, sunspots, time of day, and shortwave stations.¹⁴⁴ “Given the vagaries of shortwave reception, it is not realistic to seek to ‘protect’ such reception beyond the normal protection afforded to all radio services by operation of Part 15 of the Commission's rules.”¹⁴⁵

Southern also contended that the Commission must balance the relative interest in technologies. “On balance, the wider availability of broadband Internet access to a growing user community must be given precedence over any extreme measures that would be needed to preserve the interests of a dwindling constituency.”¹⁴⁶

3. Public Safety Broadcasters

The Public Safety Wireless Network, an association of local state, federal and tribal public safety agencies, expressed enthusiasm regarding BPL technology but expressed concerns that interference would likely result from such use, based upon the experience of foreign broadcasters.¹⁴⁷

4. Television

The Association for Maximum Service Television, Inc. and the National Association of Broadcasters contended that BPL operation at frequencies near 80 MHz, the beginning of the television broadcast frequency, would interfere with

¹⁴² National Association of Shortwave Broadcasters, Reply Comments in ET Docket No. 03-104, 1 (Aug. 20, 2003)[hereinafter NASB Reply Comments].

¹⁴³ *Id.* at 1.

¹⁴⁴ Southern Reply Comments, *supra* note 13, at 18-19.

¹⁴⁵ *Id.* at 19.

¹⁴⁶ *Id.* (citing press report that the Internet and digital satellite radio are making shortwave broadcasting obsolete in developing marketing like the U.S.).

¹⁴⁷ PSWN Comments, *supra* note 15, at 1. The Federal Emergency Management Agency filed very late comments expressing “grave concerns” regarding interference that it contended would likely be caused to government communications by unlicensed BPL systems, concluding that the deployment of BPL technology “will result in significant detriments of the operation of FEMA radio systems.” Federal Emergency Management Agency, Comments in ET Docket No. 03-104, 1-2 (Dec. 4, 2003). FEMA operates a large high frequency radio system that is the primary command and control mechanism for the agency and is used to communicate with disaster response elements at the federal, states, and local levels. *Id.*

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television signals and urged the Commission to limit BPL use to frequency bands below 50 MHz.¹⁴⁸

The low television VHF signals begin at 54 MHz, with channels 2-4 covering 54-72 MHz.

5. Wireless Providers

The Wireless Communications Association International, Inc. (WCAI), representing wireless broadband providers operating over licensed spectrum in the 2.1 GHz, 2.3 GHz and 2.5 GHz and license-exempt spectrum in the 902-928 MHz, 2.4 GHz and 5 GHz bands, expressed concerns that Access BPL systems (which it believe could operate at up to 80 MHz) could cause interference up to the tenth harmonic of the BPL operating frequency and thereby pose a threat to licensed radio service in the 700 and 800 MHz bands and to unlicensed services in the 900 MHz band.¹⁴⁹ They also contended if Access BPL operated as high as 200 MHz, as suggested by BPL technology provider Satius, it could interfere with both licensed and unlicensed operations in the 2.1-2.5 GHz and other bands.¹⁵⁰

Southern in its reply comments contended that there was no technical support for WCAI's interference claims; that many radio services WCAI represents are themselves unlicensed and operate on equal basis under Part 15 of FCC's rules and therefore have no expectation of protection from interference; and that because the primary operating frequencies for BPL will be below 50 MHz, meaning the tenth harmonic will not exceed 500 MHz.¹⁵¹ Southern contended that higher frequencies "roll off" quickly because BPL system components used to generate and carry BPL signals to the power line have characteristic impedance designed to produce fast roll off, natural impedance of power line itself suppresses frequencies above 80 MHz.¹⁵²

6. Wireless Astronomy

The National Academy of Sciences (NAS) said that BPL would cause interference to radio astronomy service (RAS), a matter of particular concern because observed signals are extremely weak.¹⁵³ NAS indicated that bands of particular concern included 13.36-13.41 MHz, 25.55-25.67 MHz, and 37.50-38.0 MHz, 38.0-38.25 MHz, 73.0-74.60 MHz, 406.1-410.0 MHz, and 608-614 MHz.

¹⁴⁸ Association for Maximum Service Television, Inc. and the National Association of Broadcasters, Joint Reply Comments in ET Docket No. 03-104, 1-2. (Aug. 20, 2003).

¹⁴⁹ Wireless Communications Association International, Inc., Comments in ET Docket No. 03-104, 2 (July 7, 2003) [Hereinafter WCAI Comments].

¹⁵⁰ Wireless Communications Association International, Inc., Reply Comments in ET Docket No. 03-104, Exhibit 1: Engineering Statement Regarding the Notice of Inquiry (ET Docket 03-104) Regarding Broadband Over Power Line Systems) ("Hardin Statement"), at 3 (Aug. 20, 2003) [hereinafter WCAI Reply Comments].

¹⁵¹ Southern Reply Comments, *supra* note 15, at 24.

¹⁵² *Id.*

¹⁵³ National Academy of Sciences' Committee on Radio Frequencies, Comments in ET Docket No. 03-104 (July 7, 2003) [hereinafter NAS Comments]. In addition to observation of distant celestial phenomena, radio astronomy techniques have contributed to the development of physics, computerized tomography (CAT) scans, earthquake prediction devices, and wireless telephone geographic location technologies. *Id.* at 2.

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Section 15.205(a) prohibits intentional transmissions by unlicensed devices in most of the above-listed bands allocated to RAS.

Southern countered by stating that three of the seven band of RAS would not be impacted because Access BPL systems are expected to operate only on frequencies below 50 MHz. It also insisted that with BPL such emissions would be minimal – “Southern has found that when in-band radiated emissions comply with the limits of Part 15, any spurs or harmonics are indistinguishable, and unmeasurable, in the system noise floor.”¹⁵⁴

7. Other Wireline Communications Providers

Verizon, Qwest and Sprint expressed concern that BPL operations could interfere with voice and data services on twisted pair telephone cables located on the same utility poles as the BPL equipment.¹⁵⁵ Verizon asserted that higher frequency energy could leak from power cables given that they are unshielded and unbalanced, and that voice and DSL energy could demodulate certain signals by extracting low frequency signals from high frequency signals and thereby create noise.¹⁵⁶

Southern in its reply comments addressed some of these assertions. Southern contended that as DSL modems are classified as Part 15 devices, they are not entitled to any greater protection from interference than BPL equipment; therefore it is incumbent on both technologies to cooperate to minimize interference. Southern and others contended that such arguments instead represented an attempt by competitor to hobble a nascent industry.

Ameren predicted Access BPL equipment would have relatively small impact upon cable televisions and telecommunications equipment because BPL's relatively large wavelength of the signals would lead to interference consisting of only common mode signals, rather than differential mode signals, because BPL spectrum does not overlap with cable or telephony spectra, and because existing noise near power lines (and cable and telephony equipment) does not cause harmful interference.¹⁵⁷ Electric Broadband said that the concerns of collocated parties may reduce over time as telephone companies replace RF-vulnerable copper wires and coaxial cable with fiber optic lines, which are more RF resistant.¹⁵⁸

D. General Testing Issues and the BPL Challenge

Many of the commenters' conflicting opinions can be attributed to a lack of hard test data regarding BPL systems and to disputes over the applicability of those tests that have been performed. The next section addresses the Commission's approach to testing carrier current systems and analyzes the limited

¹⁵⁴ Southern Reply Comments, *supra* note 15, at 19-20.

¹⁵⁵ Verizon, Comments in ET Docket No. 03-104, 2 (July 7, 2003) [hereinafter Verizon Comments]; Sprint, Comments in ET Docket No. 03-104, 3 (July 7, 2003); Qwest, Comments in ET Docket No. 03-104, 4 (July 7, 2003) [hereinafter Qwest Comments].

¹⁵⁶ Verizon Comments, *supra* note 155, at 5.

¹⁵⁷ Ameren Comments, *supra* note 34, at 10.

¹⁵⁸ Electric Broadband, *supra* note 26, at 7-8.

number of tests that were entered into the BPL proceeding record, as well as several additional planned tests.

The Commission's rules for testing carrier current systems call for measurements of radiated emissions at three installations that the operator deems as representative of typical installations.¹⁵⁹ There is no test procedure specified in the rules for carrier current systems.¹⁶⁰ The Commission has indicated, however, "that general guidance on emission measurements below 30 MHz can be found in a publication of the American National Standards Institute (ANSI)."¹⁶¹

The Commission and a number of commenters noted that BPL systems are particularly difficult to test for interference prior to deployment. BPL interference is difficult to measure because of a number of factors: 1) different delivery systems and variations in delivery components, 2) inability to test to scale and intrasystem variations that cannot be measured at all points, and 3) installation wiring functions as an antenna and wiring thereby becomes part of the system to be evaluated. Many commenters further questioned the ability to generalize from measurements made at a fully deployed system to other systems.¹⁶²

The Commission noted that In-House BPL emissions testing is difficult because impedance characteristics of in-house wiring changes each time appliance is turned on or off, making modeling varying impedance a challenging task.¹⁶³ It asked if, nonetheless, standardized measurement was possible and if different measurement methods were necessary for both traditional carrier current system and new In-House BPL.

Many commenters questioned whether existing carrier current system measurement standards are applicable to BPL. ARRL said that 15.31 measurement procedure for radiated emissions of carrier current systems at three typical or representative installations is insufficient and inapplicable to both Access and In-House BPL systems because of difficulty determining point of maximum field strength and different parts of radiating structure.¹⁶⁴

In an effort to provide data to buttress arguments, commenters submitted data from a range computer models, field tests, and limited commercial deployment designed to measure interference.

Computer models provided to date include those of Ameren, an electric utility, the ARRL, and Wireless Communications Association International. Many utilities and BPL providers provided anecdotal reports from their field tests. The FCC and the NTIA also announced that they would conduct tests that will likely be the most comprehensive of any in the proceeding and that, in the case of the Commission, will involve construction of an entire model BPL system.

Generally commenters, even those that submitted studies, have conceded submitted tests did not provide conclusive evidence regarding the degree of BPL interference: "[I]t is not possible to determine the interference potential of BPL

¹⁵⁹ 47 U.S.C. § 15.31(d) (2003).

¹⁶⁰ BPL NOI, *supra* note 2, ¶ 21 n.34.

¹⁶¹ *Id.* (citing C63.4 Methods of Measurement of Radio-Noise Emissions from Low-voltage Electronic Equipment in the Range of 9 kHz to 40 GHz).

¹⁶² See discussion *infra* at IV(D)(ii-iv).

¹⁶³ BPL NOI, *supra* note 2, ¶ 23.

¹⁶⁴ ARRL Comments, *supra* note 112, at 16.

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with a computer model.”¹⁶⁵ Ameren reached a similar conclusion for numerical models based on the finite element method “because a prohibitive computational complexity is required to calculate the radiated fields from an extensive Access BPL network.”¹⁶⁶ Problems with such tests are “there is a high degree of variability among power lines and the ways signals on power lines will tend to cancel each other out based on the number of signals on the line, directional change in the power line, devices on the line, etc.”¹⁶⁷ One Commenter urged the Commission to follow precedent in rejecting interference demonstrated by models far removed from field conditions.¹⁶⁸ A number of the broadcasters’ comments appeared to be premised upon worst-case scenarios, which the Commission has often dismissed when evaluating interference issues.¹⁶⁹

As noted above, even full-scale models of an Access BPL system may not resolve interference issues, said one commenter, noting that “there would be so many different environments that any model would be only ‘interesting’ and not practical.”¹⁷⁰

Testing by the FCC and NTIA played a decisive role in the rules that ultimately emerged in last year’s ultra-wideband proceeding.¹⁷¹ In the UWB proceeding, tests were submitted by numerous parties, including:¹⁷²

i. NTIA re harmful interference to U.S. government radio operations between 400 MHz and 6000 MHz

¹⁶⁵ *Id.* at 15; *see also* North American Shortwave Association, Comments in ET Docket No. 03-104, 7 (June 30, 2003) [hereinafter NASWA Comments](counseling against reliance upon computer modeling to predict interference); AMA Reply Comments, *supra* note 113, at 4 (“Based on the record before the Commission, it is difficult to predict the impact BPL may have on existing systems using the HF/VHF spectrum”); Main.net Reply Comments, *supra* note 122, at Exh. 1, Holger Hirsch, Comments on the Inquiry Regarding Carrier Current Systems, Including Broadband Over Power Line Systems by the FCC, p. 3. (“modeling is of limited use in determining real world emissions”); Ameren Comments, *supra* note 34, at 11-12 (“Such [analytical] models will yield only an approximation of the expected field emissions... AEC is unaware of any practical data that validate these analytical models or their accuracy.”)

¹⁶⁶ Ameren Comments, *supra* note 34, at 12.

¹⁶⁷ Southern Reply Comments, *supra* note 15, at 17.

¹⁶⁸ Current Technologies Comments, *supra* note 18, at 12 n.21 (“In the recent ultra-wideband (UWB) proceeding, where wireless PCS carriers claimed interference from UWB transmitters into their handsets based on tests in anechoic chambers. The Commission did not dispute the test results, but determined that UWB would not interfere with PCS in the radio-frequency environments in which the handsets are actually used.”) *See* UWB First R&O, *supra* note 84, ¶¶ 152-163 (2002).

¹⁶⁹ *See* Conducted Emissions Limits NPRM, *supra* note 94, ¶ 23 (dismissing an NAB argument favoring a substantial reduction in the conducted emission limits in the AM broadcast band based upon worst case assumptions such as, for example, an interference source coupled directly into the power cord of the AM broadcast receiver, whereas in practice there would normally be some length of electrical cable between the devices that would attenuate the interfering signal).

¹⁷⁰ Power System Relaying Committee of the Institute of Electronic and Electrical Engineers, Comments in ET Docket No. 03-104, 4 (July 1, 2003)[hereinafter IEEE Comments].

¹⁷¹ Ultra-wideband devices operate by employing very narrow or short duration pulses that result in very large or wideband transmission bandwidths. Devices include radar systems used to make precise distance measurements, imaging devices for seeing beneath earth or within or behind structures, and broadband communications applications.

¹⁷² UWB First R&O, *supra* note 84, ¶ 71.

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- ii. NTIA on behalf of DOT re analysis of potential interference to GPS
- iii. TDC and Qualcomm analyzed potential interference to GPS
- iv. DOD provided mathematical analysis of possible interference by UWB operation to its Space-Ground Link Subsystem at 2.2-2.3 GHz.

In addition, the ARRL calculated increases to receiver noise floors for receivers located at 420 MHz and 2500 MHz; Motorola, Sprint PCS, Telcordia Technologies, Time Domain Corporation, and Qualcomm performed analyses and testing of potential interference to PCS systems; Cisco presented an analysis of interference to MMDS systems; and XM calculated impact on satellite DARS systems.¹⁷³

As is likely to be the case in the BPL proceeding, release of an order in the UWB proceeding did not cut off testing. In the February 2003, Memorandum Opinion and Order and Further Notice of Proposed Rulemaking, the Commission expressed hope that additional tests using commercially available UWB devices would be completed and indicated that additional tests by the National Aeronautics and Space Administration, the Department of Transportation, the Department of Defense, and commercial entities were expected.¹⁷⁴ “As these steps occur, we intend to continue our review of UWB standards to determine where additional changes warrant consideration.”¹⁷⁵

1. Analysis of Submitted Models and Tests

A brief description and analysis of the major studies submitted and tests planned is provided below:

a. ARRL (Amateur Radio)

ARRL submitted five total studies, including three studies in its initial comments and two more in its reply comments. One study analyzed various methods of RF signal injection onto “medium-voltage” lines and the effect of different methods on Access BPL interference potential.¹⁷⁶ The study used an antenna-modeling program¹⁷⁷ to model a simple medium-voltage power line and two nearby amateur antennas located 30 meters from the lines. Three variations on the model reflected different means of feeding the antenna. The study concluded that at least one means of feeding the antenna (one phase differential feed) created a level of gain higher than many antennas intentionally deployed by Amateurs at the 14 MHz band. It concluded that the other alternatives, while less problematic, also raised interference concerns. The graph below depicts the complex pattern of signal radiated from the simulated line.

¹⁷³ *Id.*

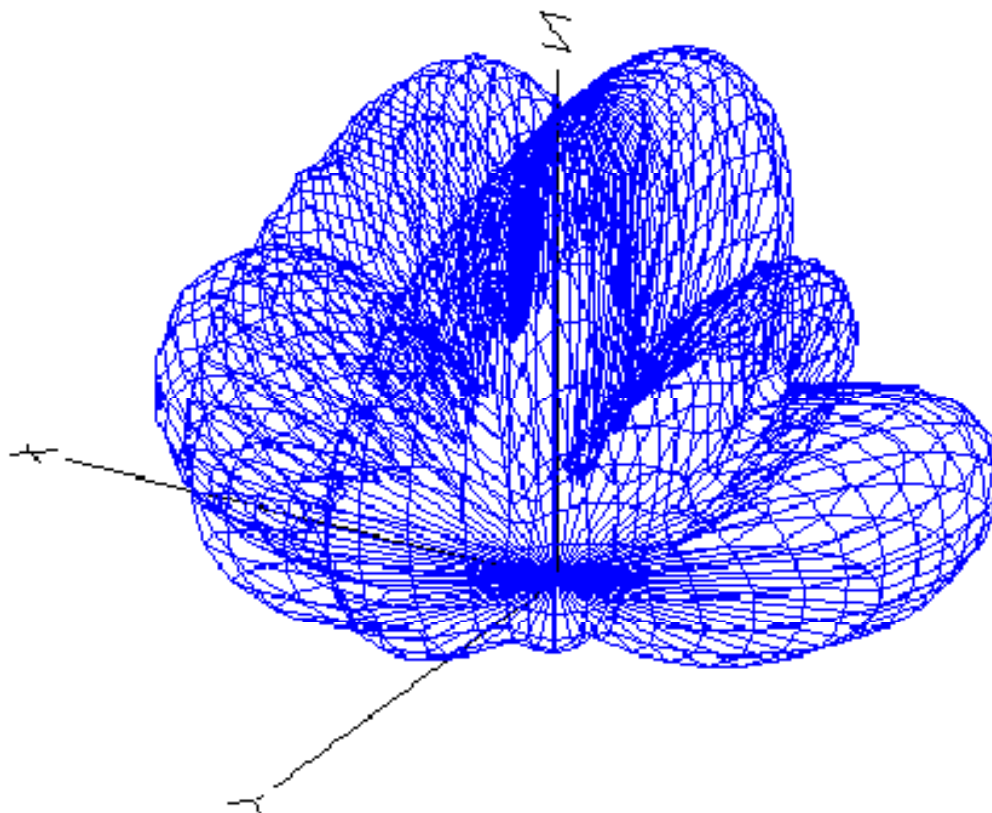
¹⁷⁴ UWB MO&O/FNPR ¶ 1.

¹⁷⁵ *Id.*

¹⁷⁶ ARRL Comments, *supra* note 112, at 8-9, Exhibit B.

¹⁷⁷ *Id.* at 9 (using EZNEC/4 with the NEC-4 calculation engine).

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It can be argued that the model does not accurately depict a power line with BPL, because the model is ‘taken out of context’. Given that a typical line carrying a signal at 30 MHz supports mostly transverse electromagnetic modes, and therefore acts as a waveguide, emissions from it occur primarily at points of discontinuity¹⁷⁸. In the described case, the distance between the two discontinuity points is small, and therefore the emissions are highly concentrated and form the pattern we observe. While a similar picture can depict certain parts of the grid with a high concentration of junctions, transformers, and capacitors, it is not representative of the long stretches of power line, which are the primary concern for the ARRL’s argument.

The second study¹⁷⁹ attempted to calculate the interference potential of an emitter operating at the Part 15 radiated emissions limits that apply to carrier current devices. Derived levels of interference were then used to determine the level of degradation in the ambient noise level at the receiver of several typical HF and VHF amateur station installations.

The second study concluded that the radiated emissions were high enough that the signals from BPL emitters would be received by nearby antennas, with received signal levels of BPL noise at typical amateur stations at between 33.7

¹⁷⁸ Ameren, Reply Comments in ET Docket No. 03-104, 3 (Aug. 20, 2003) [hereinafter Ameren Reply Comments].

¹⁷⁹ ARRL Comments, *supra* note 112, 10, Exhibit C.

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and 65.4 dB higher than typical ambient noise.¹⁸⁰ This level of noise, if it were indeed present, and if other study assumptions were true, would incapacitate most of existing amateur radio installations. ARRL concluded based on that evidence that “BPL cannot be deployed using Amateur allocations in the MR, HF and VHF bands without severely high interference potential.”¹⁸¹ It also concluded that even for spectrum outside that in with Amateurs broadcast, Amateurs whose antennas must be located closer than 30 meters from the radiating power lines would need up to 100 dB of suppression of spurious BPL emissions to operate free of harmful interference.¹⁸²

The third study examined electric and magnetic fields near physically large radiators, which ARRL contended revealed “extremely complex” radiated patterns from a simplified power line model developed under the program and calculation engine used for the other tests.¹⁸³

As in the case of the first study, the results of these studies can be questioned based on the assumptions used in the model. For example, Ameren, one of the BPL proponents, contended that the model employed by ARRL was atypical to that used on power systems because it was based on a single line and did not account for the fact that single transmission lines radiate differently when operated isolated from the network than when embedded.¹⁸⁴ ARRL’s 50 ohm resistance representing the system load and modems is also inadequate at higher frequencies. Furthermore, Ameren also asserted that ARRL used an improper equation resulting in large antenna gains¹⁸⁵ and that ARRL improperly discounted the effects of load conditions and losses upon antenna gain.¹⁸⁶ These objections are reasonable and need further discussion. The inconsistencies in the results obtained by Ameren and ARRL can be attributed to ARRL’s lack of data. As ARRL indicated in its comments, “[m]anufacturers have not published much technical data and the information in the required semiannual reports on the FCC experimental licenses has either not yet been filed, has been filed under a confidentiality request or does not contain much specific information about BPL-system power levels, power-spectral density or losses through the couplers used to connect BPL systems to MV lines.”¹⁸⁷ In this case, the basic assumptions made by ARRL experts were based on insufficient data, and the interference levels reported are incorrect.

ARRL supplemented its reply comments with two additional studies. The first study, BPL and Conducted Emissions,¹⁸⁸ concludes that BPL systems, as configured per information from the BPL industry, will change the conducted EMC environment from the present level of +48 dBuV peak in a 9 kHz bandwidth to a level of +96.5 dBuV, an increase of 48.5 dB. Largely because of

¹⁸⁰ *Id.* at 11.

¹⁸¹ *Id.*

¹⁸² *Id.* at 12.

¹⁸³ *Id.* at 15.

¹⁸⁴ Ameren Reply Comments, *supra* note 178, at 15.

¹⁸⁵ *Id.* at 17.

¹⁸⁶ *Id.* at 18.

¹⁸⁷ ARRL comments, *supra* note 112, at 71

¹⁸⁸ ARRL Reply Comments, *supra* note 125, at Exhibit B.

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high-pass couplers allowing BPL signals to be transmitted around step-down transmitters, which normally offer attenuation to noise signals generated on the low-voltage side, ARRL contended that the level of conducted noise possibly affecting equipment could increase by more than a million times.¹⁸⁹

ARRL contended that scientific testing by manufacturers whose equipment might be affected was necessary to determine the level of possible effect. It is hard to verify the results obtained by the ARRL for the same reasons noted before – primarily, the assumptions about the BPL systems and the limitations of modeling as a general approach to measuring interference of complex systems of such scale. Establishing the “threshold” and the “tipping point” of noise in the band is the prerogative of the Commission and the NTIA, and it is too early to make claims concerning these issues.

ARRL conducted a second study analyzing skywave propagation of BPL noise in terms of predicted communications circuits on two “typical” Amateur Radio HF allocations.¹⁹⁰ It concluded that the present levels of noise from unlicensed devices and other sources is at the “edge of degradation” of the ability to communicate using a typical Amateur station on the subject bands and that “even a modest increase” over the present median noise levels has a significant adverse effect on the reliability and range of HF communications.¹⁹¹ A 10 dB degradation of communications would result in “transformation of the 14 MHz Amateur band from a worldwide communications band as it is now to one of limited regional communications capability, assuming power levels typically deployed at Amateur stations.”¹⁹²

An additional exhibit provided by ARRL documents ARRL’s testing at BPL field trial areas to verify previously made calculations.¹⁹³ Although some measurements of field strength were performed, the primary purpose of ARRL’s visits to the field trial areas was to use listening tests to demonstrate and document the applicability of ARRL’s interference calculations to the real-world impact of BPL emissions on HF communications circuits.¹⁹⁴ Several different receivers were used with a “reasonable” mobile HF amateur station. The field tests were performed at four BPL test sites: Potomac (MD), Manassas (VA), Emmaus (PA), and Briarcliff Manor (NY), in the end of July 2003. ARRL reported “strong to severe” levels of noise detected at the test sites, with BPL noise field strength at one of the locations reaching 23.0 dBuV/m. However, “quiet” installations were also reported, leading ARRL to note, “under some circumstances, it is possible for BPL systems to operate well below the radiated emissions limits in the present rules.”¹⁹⁵

At the same time, energy and BPL technology providers report that they haven’t received interference complaints at the test sites. This shows that field

¹⁸⁹ *Id.* at 3.

¹⁹⁰ *Id.* at 4, Exhibit C. Such allocations were located at 14 MHz and 5 MHz and were described as “typical.” *Id.* at 4.

¹⁹¹ *Id.*

¹⁹² *Id.* at 4-5.

¹⁹³ *Id.*, Exhibit A.

¹⁹⁴ *Id.*, Exhibit A, at 1.

¹⁹⁵ *Id.*, Exhibit A, footnote at 3.

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tests, conducted jointly by the BPL proponents and opponents, would be able to effectively look for problematic areas of BPL installations, find specific affected services, and resolve the issues if they are found. Larger commercial test deployments and higher levels of cooperation would be required to fulfill this task.

b. Wireless Communications Association International

The WCAI, representing wireless broadband providers operating over licensed spectrum in the 2.1 GHz, 2.3 GHz and 2.5 GHz and license-exempt spectrum in the 902-928 MHz, 2.4 GHz and 5 GHz bands, accompanied its reply comments with an engineering statement concluding that BPL may cause both radiated and conducted interference to wireless broadband customer equipment.¹⁹⁶ The statement concluded that a 1 dB degradation in receiver noise floor would result in a 10% to 20% reduction in a wireless broadband systems' coverage area, depending on the selected propagation model.¹⁹⁷ Modeling the heightened emissions limits proposed by Satus, it further concluded that a BPL system would cause a 64.15 dB degradation in the noise floor even if located 100 meters from a wireless broadband base station operating in the 2600 MHz band, and a 49.15 dB degradation in the noise floor if located 100 meters from a wireless broadband handset operating in the 2600 MHz band.¹⁹⁸

WCAI also contended that conducted interference could lead to such signal anomalies as signal transmissions outside of ranges permitted by the Commission's rules, degraded receiver noise floor, oscillator drift and similar phenomena.¹⁹⁹

While the study provided by the WCAI (the Hardin statement) presents extensive results, the methodology is not clearly described, and the study does not specify the assumptions made while performing the calculation. It remains up to the tests to verify the results.

c. Ameren

Ameren Energy Communications, Inc., which received an experimental license to deploy a limited experimental BPL system in Cape Girardeau, Missouri, generalized upon its field testing and theoretically calculated radiation patterns for a four conductor overhead distribution lines.

Ameren asserted that its tests refuted other parties' assertions that BPL will act as one long antenna, instead contending that BPL emissions come from only short stretches of the power line adjacent to the BPL device.²⁰⁰ It submitted analysis indicated that radiation efficiency and gain should be computed based upon maximum source capacity rather than coupled power. Doing so yields radiation efficiency and gain suggesting that single lines are expected to be

¹⁹⁶ WCAI Reply Comments, *supra* note 150, at Exhibit 1.

¹⁹⁷ *Id.* at 3, Exhibit 1, p. 4.

¹⁹⁸ *Id.* at 3, Exhibit 1, p. 5-7.

¹⁹⁹ *Id.* at Exhibit 1, p. 8.

²⁰⁰ Ameren Reply Comments, *supra* note 178, at i.

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inefficient radiators and that the vicinity of the BPL source is the critical part of the system for determining radiation.²⁰¹

Ameren suggested that its testing rebutted the assertion by some commenters that because a power line has many conductors, their combined effect would be similar to that of an array antenna, resulting in amplification of radiation. It contended that BPL architecture permits only one cell to transmit at a time, resulting in only one modem operating at any point in time in any given cell and therefore, only a single emissions source.²⁰² Ameren also cited an analysis²⁰³ of partially deployed networks and concluded that large deployments of local access telecommunications systems using low voltage electricity distribution networks would not changed below -40 dBMHz^{-1} , a power output ability that BPL modems employed by Ameren fall well within.²⁰⁴

d. NTIA

In its comments, the NTIA indicated that it had initiated modeling and analyses that address the interfering potential of BPL technology and the radiated emission limits needed to preclude unacceptable interference to federal government systems.²⁰⁵ NTIA indicated that its efforts would include research of relevant technical studies and measurement efforts performed elsewhere by other countries.²⁰⁶ NTIA also indicated that its Institute for Telecommunication Sciences was commencing measurements of experimental BPL systems: "The measurements are designed to define the local ambient noise environment and reveal the most important BPL radiated emission characteristics for use in NTIA's modeling efforts."²⁰⁷ In an appendix, the NTIA described elements of its planned study, with analyses apparently to be performed in coordination with a system operator using various BPL systems.²⁰⁸ NTIA said it expected to conclude its modeling, analysis and measurement efforts by the end of 2003 and would submit its findings to the Commission.²⁰⁹

²⁰¹ *Id.* at 12.

²⁰² *Id.* at 13.

²⁰³ *Id.* at 14 (citing Hanspeter Widmer, Proceedings of the 2000 International Zurich Seminar on Broadband Communications, pp. 179-84 (15-17 Feb. 2000)).

²⁰⁴ *Id.* A similar point was made by another commenter, Current Technologies. *See* Current Technologies Comments, *supra* note 18, at 15 n.25 (Contending that a 10 BPL-equipped transformers 100 meters away from a victim receiver yielded a total signal at the receiver yielded a combined signal only 8% of a BPL-equipped transformer on a pole 9 meters above a victim receiver).

²⁰⁵ NTIA Comments, *supra* note 11, at § III.

²⁰⁶ *Id.*

²⁰⁷ *Id.*

²⁰⁸ *Id.*, Appendix A.

²⁰⁹ *Id.* at § III. At an industry conference on December 12, 2003, NTIA Acting Director Michael Gallagher offered additional details regarding BPL testing. Dinesh Kumar, COMMUNICATIONS DAILY, Dec. 12, 2003. Gallagher said that a Phase I report will address local interference problems such as those in houses and neighborhoods and recommend emissions limits and compliance measurement procedures and that the findings will then be submitted to the Commission. *Id.* He said that the 2nd phase of the NTIA study of interference risks will deal with long-range effects of BPL, assuming there is robust deployment of the technology. *Id.* Gallagher said that the agency so far has measured more than 10 million BPL samples over 8 weeks in 3 cities and has developed

e. FCC

The Commission offered preliminary tests performed by the Commission's laboratory Test Program, an effort primarily designed to allow the Commission to assess conducted alternatives to the radiated emissions testing presently required for in-home power line communications devices operating under Part 15.²¹⁰ The Commission described the test as an attempt to determine whether standardized laboratory testing could replace on-site testing that is expensive and yields results that are not easily repeatable due to variations between installation sites.²¹¹ The test was of only a single house and involved measuring emissions from mains wiring of houses while injecting radio-frequency signals into power outlets of the houses. The test method is an adaptation of that used in CISPR 22 for telecommunications ports.

The test method, CISPR/I/44/CD, proposes applying the CISPR 22 telecommunication port conducted limits to PLC. The Commission in an earlier version of the document concluded that the thresholds and the 36-dB LCL value proposed in the CISPR/I/44/CD would "appear" to permit significantly higher radiated emissions than the current FCC limits allow but that "testing in more houses will be necessary to confirm this conclusion."²¹² The study also displayed higher emissions for asymmetric injection are higher than for symmetric injection.²¹³

Ameren recommended certain modifications of the Commission's proposed testing procedures,²¹⁴ including the observation that use of a loop antenna could introduce significant errors when measurements are made near a power line or a house because of the behavior of the cumulative wiring of a house as a large radiator.²¹⁵

2. Field Tests

Most BPL equipment developers have created small to medium size BPL-equipped areas for testing. Energy utility and BPL technology providers generally reported that a lack of harmful interference was demonstrated by their test projects.²¹⁶ However, these data are generally not quantified or qualified, so it

computer models to characterize potential BPL emissions. *Id.* Gallagher said the BPL range of interest for the agency was 1700 kHz to 80 MHz and there were more than 80,000 assignments for federal government operations in those frequency ranges. *Id.*

²¹⁰ Office of Engineering and Technology, Comments in ET Docket No. 03-104 (Sept. 16, 2003)(Initial results of FCC tests related to in-house Power Line Communications (PLC), CISPR/I/WG3/ISN Task Force (Martin) 03-01 (Sept. 15, 2003)).

²¹¹ *Id.* at 1.

²¹² *Id.* (July 30, 2003 version), at 13. The September 15, 2003 version of the report said that the measurements taken for the test house showed predicted radiated levels exceeded current FCC limit by 18 dB for a class A device and 5 dB for class B device. *Id.* (September 15, 2003 version) at 12.

²¹³ *Id.* at 9-10.

²¹⁴ Ameren Reply Comments, *supra* note 180, at 21-25 (commenting on the July 30, 2003 version of the study).

²¹⁵ *Id.* at 23 n.25, Appendix B.

²¹⁶ See Ameren Comments, *supra* note 34, at 12 ("From an emissions and interference standpoint, operations thus far have been entirely positive," including no BPL emissions exceeding Part 15

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remains to be seen what kinds of possibly affected services were monitored and how the testing was performed. One possible pitfall of field-testing is relying on the level of complaints: unless the users in the test area are trained to distinguish malfunctioning of appliances and other service impairment causes from interference-related ones, many will ignore the inconvenience, ascribing it to other reasons.

Field-testing areas and results have become a matter of significant debate. ARRL accused power companies of lack of cooperation when they tried to take measurements.²¹⁷ ARRL also said that power companies have withheld evidence by failing to disclose information from periodic reports required by their experimental licenses.²¹⁸ They claimed that trial area are small to moderate in size and are all single-family homes.²¹⁹ Amateur radio operators also complained of being denied access to field tests.

Significantly, the Commission is creating a full-scale Access BPL model at a test facility in Maryland that will likely provide the most extensive and best controlled environment for BPL interference testing.

In addition to its own facility, the Commission should require both sides to agree to standards for site visitation, preferably at the same time.²²⁰ Simultaneous testing would provide a check on each side's reporting and would allow common testing of background noise. The Commission should order that such tests be conducted as soon as possible and soon enough to allow for inclusion of results in the proceeding and for deliberation by the Commission.²²¹

above 30 MHz, some emissions above Part 15 observed between 2 and 30 MHz probably caused by BPL, but most within 20 meters to lines and rapid decreases at further distances, including no appreciable emissions at distances beyond 200 meters from the lines.; no emissions above the Part 15 limits observed outside the geographical area of the cell, and no complaints of interference from test participants or third parties.); Southern Comments, *supra* note 35, at 19; Ameren Comments, *supra* note 34, at 9 (no reports of interference in connection with its BPL trial running past approximately 300 homes); Hawaiian Electric Comments, *supra* note 20, at 4 (no interference complaints during its first three-month deployment of BPL); Progress Energy Comments, *supra* note 19, at 6 (no reported instances of interference during field trials); Amperion Comments, *supra* note 15, at 2 (no complaints or instances of interference at any of its deployments of equipment); PowerWAN Comments, *supra* note 19, at 3 (field tests have not resulted in any complaints from either customers or customer neighbors); Electric Broadband Comments, *supra* note 26, at 3 (in work with vendors and utilities using BPL technology, no interference issues have arisen under existing rules for carrier current systems).

²¹⁷ ARRL Comments, *supra* note 112, at 17.

²¹⁸ ARRL Reply Comments, *supra* note 125, at 7.

²¹⁹ *Id.* at 9. One commenter notes that some tests have occurred in subdivisions, a location that might minimize complaints by amateur radio enthusiasts because such subdivisions are governed by covenants, conditions and restrictions that prohibit installation of outdoor antennas used by amateur radio enthusiasts. Michael Keane, Reply Comments in ET Docket No. 03-104, 5 (Aug. 20, 2003)[hereinafter Keane Reply Comments].

²²⁰ If utilities have concerns regarding providing access to critical infrastructure systems, they may reasonably insist upon use of proxies mutually acceptable to both sides.

²²¹ Some commenters have helpfully noted the availability of inexpensive equipment that they contend would accurately model interference to their communications applications. *See* NASWA Comments, *supra* note 165, at 7.

3. Commercial Deployments

The most relevant form of data, of course, would come from actual deployment of commercial systems. As one commenter noted, “on-site measurement remains the gold standard.”²²² The commercial deployments of BPL will likely rapidly demonstrate whether BPL will or will not interfere. While such deployments will contain elements specific to any particular BPL system, they will provide a range of potential interference situations that will greatly augment the Commission’s knowledge. As recommended above for field trials, the Commission should require full testing and access to spectrum users at deployment sites.

4. Standardized Testing

Given the disparity in deployment technologies and conditions, the Commission asked if standardized measurement is possible and would be desirable. While utilities and BPL providers generally opposed an interventionist role in standards setting for BPL technology,²²³ they appeared to agree that measurement standards imposed by, or in conjunction with, the Commission would be welcome.²²⁴ For example, Ameren said that measurement standards would definitely assist the industry’s development.²²⁵ Current and Amerperion recommended a collaborative effort between BPL industry and the Commission to develop a standardized measurement procedures.²²⁶ Southern urged a rapid timeframe for developing procedures for testing to provide regulatory certainty regarding this precondition to BPL deployment.²²⁷ Adaptive Networks, Inc., an In-House BPL technology provider, filed comments recommending modifications for the ANSI C63.4 Measurement Procedures for use with carrier current systems.²²⁸

On the other hand, the UPLC asked FCC to retain existing procedures because of the danger of delay to BPL deployment if measurement standards are implemented, because current standards are accurate, and because of the possible imposition of emission limits more stringent than necessary to protect licensed users.²²⁹

What does seem clear is that increased, simultaneous participation in testing should occur. As suggested by one commenter, the Commission should establish and advisory group of government and industry technical experts to examine the results of testing²³⁰ and such processes should involve all affected parties.²³¹ The

²²² Current Technologies Comments, *supra* note 18, at 19.

²²³ See discussion *infra* at Part V(E).

²²⁴ Southern Comments, *supra* note 33, at 22; Amerperion Comments, *supra* note 15, at 7-8; Current Technologies Comments, *supra* note 18, at 18-19; Main.net Comments, *supra* note 32, at 8-10.

²²⁵ Ameren Comments, *supra* note 34, at 15.

²²⁶ Amerperion Comments, *supra* note 15, at 7-8; Current Technologies Comments, *supra* note 18, at 18-19; Southern Reply Comments, *supra* note 15, at 29.

²²⁷ Southern Reply Comments, *supra* note 15, at 29.

²²⁸ Adaptive Networks, Comments in ET Docket No. 03-104, 1 (June 25, 2003).

²²⁹ UPLC Comments, *supra* note 6, at 13.

²³⁰ MCI, Alts and Covad, Joint Comments in ET Docket No. 03-104, 4 (Aug. 20, 2003).

²³¹ *Id.*

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Commission may also wish to condition future experimental licenses upon reports of EMC measurements from their trials.²³²

5. Summary

It is clear that objections can be drawn to every form of testing and modeling that will be submitted into the record. Studies submitted to date, however, are sufficient to raise concern over possible interference to licensed users. Test results yet to be submitted by the FCC and the NTIA will likely form the most influential ones in the Commission's decision-making process, as may results from early commercial deployments. Every effort should be made to expand the number of tests and the range of participants to ensure that the Commission enjoys as full a record as possible when it begins consideration of changes to its Part 15 rules.

V. How Interference Concerns Should Be Addressed

Interference concerns are central to the Commission's NOI. If the Commission determines that operation of BPL equipment does not significantly interfere with licensed and non-licensed spectrum users, it will probably recommend leaving its rules as they are, or possibly allow a modest increase in emissions under carefully controlled conditions.

If, however, spectrum users' interference concerns prove to be well grounded, the Commission will be forced to decide between recommending several different options. It will need to decide whether to suggest rules limiting BPL service to a certain frequency range or notching to prevent transmission within certain frequencies. It also will have to decide upon whether both the existing radiated and conducted emissions measure should apply, and whether existing emissions standards for each should be modified. It will, finally, need to decide what level of equipment authorization procedure should be adopted and whether to impose equipment standards upon BPL technology providers.

A. Interference Concerns and Testing in Past Proceedings

One of the ways to approach the BPL interference issue is to look at the manner in which previous similar technological problems were handled by the Commission.

The first examples that come to mind are direct competitors of BPL – xDSL and cable modem technologies. However, the level of interference concerns for these technologies has not been as high. While Satius, Inc. argues that DSL systems cause higher interference to telephone cables than BPL²³³, these are special cases and cannot be generalized. DSL does not use the entire swath of spectrum, does not involve infrastructure covering entire communities, and does not use a shared wiring system that puts the broadband system on the same conductors feeding multiple houses from the same transformers. Besides, current DSL systems stop at 1.1 MHz, which is below the 1.7-80 MHz range in question,

²³² See generally Keane Reply Comments, *supra* note 219, at 11.

²³³ Satius Comments, *supra* note 48, at 6

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and use twisted pair wiring, a weaker emitter.²³⁴ Another commenter noted that the same emissions concerns do not arise for cable modem service because it uses coaxial cable, whose shielding generally blocks emissions.²³⁵ Therefore, DSL and cable modem did not involve similar interference concerns, and cannot provide models for Commission treatment of BPL.

The Commission has, however, had to balance the promise of new technology and the danger of interference with existing users in past proceedings. The Commission has touted its rules limiting interference created by Ultra-Wideband (UWB) technology as an example of successful balancing of implementation of a new technology and protection for incumbent spectrum users threatened with interference from the new use.²³⁶ The approach taken by the Commission in the UWB and unlicensed PCS proceedings is discussed *infra*.

On the other hand, as a worst case scenario of interference, one commenter pointed to the Commissions' experience in the 800 MHz frequency band, where allocation and operating rules placed cellular operations adjacent to and interleaved among the frequency assignments for public safety and other land mobile operations, causing interference to the latter.²³⁷ The cost to re-band to resolve the interference problems as cellular and land mobile use expanded is close to \$1 billion.²³⁸

B. The Commission's Spectrum Regulatory Options

The Commission clearly must address the interference concerns of spectrum users, some of which appear to be well warranted. Below, some of the Commission's regulatory options are explored. Preliminary analysis provided by the Commission and NTIA tests, and possibly data from commercial deployments, will likely drive the ultimate conclusions reached by the Commission. As noted above, In-House BPL systems appear to be of greatly less concern to competing users of spectrum. Reference below to BPL will refer to Access BPL unless otherwise indicated.

1. Ban Per Se

The Commission could ban BPL per se. As noted, many commenters contended that absolute bans of BPL systems from use of frequencies used by their members would be necessary to protect them. The cumulative effect of limits requested by existing users, if implemented, could also make BPL deployment infeasible. Commenters also noted widespread opposition to BPL by broadcasters in Europe²³⁹ and some limitation of BPL in at least one European

²³⁴ ARRL Comments, *supra* note 112, at 2 n.1.

²³⁵ WCAI Reply Comments, *supra* note 150, at Exhibit 1, page 3

²³⁶ See, e.g., Kathleen Z. Abernathy, Reaching Broadband Nirvana (United Power Line Council Annual Conference Remarks of Commissioner Kathleen Q. Abernathy (September 22, 2003) [hereinafter Abernathy UPLC Speech].

²³⁷ AMA Reply Comments, *supra* note 113, at 4.

²³⁸ *Id.*

²³⁹ National Association of Shortwave Broadcasters, Comments in ET Docket No. 03-104, 2-3 (July 7, 2003)[hereinafter NASB Comments].

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country and Japan.²⁴⁰ By contrast, however, the European Union allows companies whose equipment is approved by an EU Competent Body to deploy BPL systems in all member states of the EU,²⁴¹ though some commenters noted that emissions limits for European BPL systems are substantially lower than the Part 15 limits.²⁴²

On the whole, however, the European Union appears to be steering itself toward a similar approach to broadband regulation as the Commission. An internal working document circulated by the European Commission (EC) showed that the EC was leaning toward minimal regulation for its nascent power line communications (PLC) industry, equivalent to BPL.²⁴³ The document circulating among the member states says the EC would consider adopting a recommendation on PLC regulation and standards by the end of the year if the "wide-ranging" dialog with member states results in a consensus.²⁴⁴ Like the FCC's NOI, the EC document stresses technical issues. A joint workshop of regulatory experts of the EC's Radio Spectrum Committee, the Communications Committee and others took place on October 16, 2003, and participants decided to meet again to discuss a proposal for BPL, probably in January 2004, with a recommendation from the group for a Commission Recommendation on PLC expected thereafter.²⁴⁵

Banning BPL is somewhat undercut by the comments of some existing spectrum users that BPL could be safely confined to certain spectrum bands.²⁴⁶

²⁴⁰ See PSWN Comments, *supra* note 15, at 4 (stating that the government of Finland has refused to authorize power line communications, Radioamatoori (pp. 12-17, June 2001); see also Gerhard Latzin, PLC for the present rejected by Finnish Telecommunication Minister, May 25, 2001, published on the Internet at www.darc.de/referate/emv/lc/plc-oh-pdf. The Japanese Ministry of Public Management, Home Affairs' ruled that power leakage from power lines providing Internet access means that it was "too early" to allow PLC between 2 MHz and 30 MHz due to effects on high frequency users (http://www.jarl.or.jp/english/4_Library/A-4-News/jn0208.htm), though the government and industry continue to work together on addressing interference concerns: see Power-Line Communication to Make Step Forward, Jiji Press Ticker Service, Nov. 4, 2003 ("regulatory authorities are expected to give the go-ahead for trial tests of the so-called 'power-line communication' technology by the END/LK/HI of this year."); see also Zachary D. Little, Comments in ET Docket No. 03-104 (May 5, 2003).

²⁴¹ See Main.net Reply Comments, *supra* note 122, at 4 (also noting that Main.net has such approval). See also Radio Spectrum Committee, European Commission, Working Document on Broadband communications through powerlines at 5 (June 3, 2003) [hereinafter EC Working Document] ("operators of powerline communications networks need adequately to protect radio communications and other devices and systems which might be disturbed or whose performance might be degraded. Provided that they give such protection, they are allowed under the Directive to be put into service and operate." The cited Directive is Council Directive 89/336/EEC of 3 May 1989 on the approximation of laws of the Member States relating to electromagnetic compatibility, OJ L 139, 23.5.1989, p. 19, as last amended by Directive 93/68/EEC (OJ L 220, 30.8.1993, p.1).

²⁴² See Aura Communications, Inc., Comments in ET Docket No. 03-104, 1 (June 30, 2003).

²⁴³ EC Nudges Member States to Deploy Broadband over Power Lines, COMMUNICATIONS DAILY, July 28, 2003.

²⁴⁴ EC Working Document, *supra* note 243, at 3.

²⁴⁵ *Id.* at 2; E-mail from Leo Koolen, European Commission, to author David Tobenkin, November 4, 2003.

²⁴⁶ See, e.g., NASWA Comments, *supra* note 167 at 3.

Indeed, taking a cue from real property owners' NIMBY²⁴⁷, a none-too-subtle form of Not In My Bandwidth appears to be at work. Not all current spectrum users recommend a ban. A research group of amateur radio operators did not call for a ban, but rather emphasized testing and caution to avoid interference concerns. AMRAD noted that the lack of high speed Internet connections to homes was of concern to members and that "the addition of the power companies as another source of high speed Internet connections is seen as desirable and useful."²⁴⁸ Likewise, the Academy of Model Aeronautics, while concerned about possible interference, "acknowledges the great potential of BPL technology."²⁴⁹

A ban ignores the large technological advances that have made BPL a viable broadband competitor and possible future advances that would make it more so. Most importantly, however, a ban would deny utilities the ability to improve vital reliability, efficiency and safety factors to the nation's electric grid system.

Further, as noted, Part 15 already effectively bans emissions in excess of existing rules. The relatively limited rollout of limited commercial deployments by many manufacturers should give existing spectrum users ample time to demand that the Commission enforce its rules in the event of interference violations.

2. Ban until Proven Harmless to Competitors

A number of potentially affected spectrum users and broadband competitors contend that BPL proponents should be forced to demonstrate no harm to their spectrum before it should be deployed. The incumbent local exchange carrier commenters took this approach.²⁵⁰ However, such an approach would essentially be asking the new industry to prove a very elusive negative, given the variety of BPL systems and deployment circumstances.

Such a delay might prove as fatal as a permanent ban. Hobbling BPL with a six-month to year delay before tests (relatively) disproved concerns regarding harmful interference could prove fatal to the industry. Furthermore, many BPL opponents have themselves conceded that proof of non-interference will not be possible until commercial systems are deployed, primarily because of the difficulty of testing.²⁵¹

As noted above, the relatively limited deployments announced by electric utilities to date will moderate such risk. Further, a blanket delay of deployment until demonstration of no risk to competing distribution systems would be inequitable to those BPL systems that do not cause harm.

3. Confine to Certain Frequencies

As noted, some spectrum users, such as the amateur radio operators and some shortwave radio broadcasters, contend that all frequencies in which they

²⁴⁷ Not In My Backyard.

²⁴⁸ AMRAD Comments, *supra* note 140, at 1

²⁴⁹ AMA Reply Comments, *supra* note 113, at 2.

²⁵⁰ Qwest Comments, *supra* note 155, at 2.

²⁵¹ See discussion *supra* at Part IV(D).

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operate should be excluded from BPL use.²⁵² The Commission could attempt to address their concerns by essentially limiting BPL to a portion of the 1.7 MHz to 80 MHz frequency range to avert interference concerns. Confining BPL to a relatively smaller band of frequencies (possibly different for different BPL frequency applications) would allow licensed and other users to avoid the occupied frequencies.

Amateur radio commenters noted that BPL's use of a wide bandwidth increases the problem of interference by reducing the ability of the emitter and the affected licensed service to adjust frequencies. NASWA also contended that allowing wide deployment save in excepted bands would be improper because it would lock the Commission into bands due to the costs of redeployment of systems.²⁵³ NASWA recommended that the Commission limit BPL to the spectrum range of 30 to 47 MHz, given declining use of this range as public safety and law enforcement services migrate to 800 MHz trunked systems.²⁵⁴ Confining Access BPL to higher frequencies may help isolate it from bands dominated by more vulnerable analog signals. As the Commission has noted, "Digital signals are inherently more robust, and resistant to interference, than analog signals. Moreover, digital signal processing techniques, such as coding and error correction, are more effective at rejecting interfering signals. Thus, spectrum policies can and should reflect this increase ability to tolerate interference."²⁵⁵

Some BPL advocates suggest that more spectrum will become available as existing analog services are migrated to digital signals.²⁵⁶ It is important to take into consideration what the future of radio may hold. The emergence of broadcasts transmitted digitally as packet data and available over the Internet or a narrow radio band (i.e., Internet Radio) could significantly reduce the number of frequencies allocated to specific broadcasters and allow for new technologies, such as BPL, to use wider bands in the near future and develop successfully. Still, for the immediate future, the lower portion of the range proposed for BPL is of unique value to analog uses and also involves international considerations of the ability of foreign broadcasters to reach U.S. listeners. Unfortunately, technology probably will not dramatically reduce the bandwidth needed by BPL and its interference potential given that the technology is already digital, and already has a standard interference and signal characteristics, and because the other primary means of addressing interference concerns, shielding electrical wiring, is prohibitively expensive.

Amateur radio operators also had their own ideas regarding relocation, suggesting that the electric utilities could use the recently established Unlicensed

²⁵² See NASB Comments, *supra* note 239, at 1 ("BPL should not be authorized at this time."); North American Shortwave Association, Reply Comments in ET Docket No. 03-104, 2 (Aug. 20, 2003)[hereinafter NASWA Reply Comments]("until the industry can prove interference will not occur... the FCC must ban the commercial deployment of this technology at any level.").

²⁵³ NASWA Comments, *supra* note 165, at 5.

²⁵⁴ *Id.* at 3; see also PowerWAN Comments, *supra* note 19, at 3-4 (noting that the 30 to 50 MHz band was relatively less congested).

²⁵⁵ SPECTRUM POLICY REPORT, *supra* note 111, at 13.

²⁵⁶ PowerWAN Comments, *supra* note 19, at 4.

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National Information Infrastructure band at 5 GHz for BPL instead of the 1.7 to 80 MHz band.²⁵⁷ This, however, would call for a different technology than BPL.

BPL advocates generally opposed the frequency limitation option. UPLC claimed it was unwarranted given a lack of a record of interference.²⁵⁸ A blanket limitation would negate the achievements of some vendors in systems operating at frequencies below 30 MHz. Other disadvantages of this approach include the necessity to deal with out-of-band transmissions that could impair adjacent frequencies. PowerWAN indicating that “definition of frequency bands that must be avoided or have significant signal attenuation would help, especially in particular areas such as the amateur radio bands.”²⁵⁹

Rather than a limitation to a portion of the 1.7-80 MHz band, some BPL technology providers advocated definition of frequency bands to be avoided or have significantly attenuation and the use of notching to avoid such bands.²⁶⁰ The UPLC, however, said that such an approach would lead to a “free-for-all” that would compromise BPL’s ability to function.²⁶¹ As noted above, notching appears to address the interference issues of some applications (In-House BPL) for some rival spectrum users (amateur radio) but would not for other, such as shortwave.²⁶² In addition, notching for domestic users would compromise international users experience.²⁶³ The Commission should request additional test data regarding the feasibility of Access BPL notching. Upon a showing that such notching techniques are dynamic and can be deployed readily, flexibly, and effectively to address spot interference issues, the Commission might wish to avoid prophylactic, *a priori* limitations and instead craft a policy to apply such notching upon demonstrations of harmful interference, save in bands where interference problems are so pervasive that absolute notching must be imposed.

Frequency band limitations have been applied in some Commission proceedings. This approach was taken in the UWB proceeding. Different categories of some UWB devices were limited to different frequency bands.²⁶⁴

²⁵⁷ Gary W. Box, Reply Comments to comments filed by PowerWAN in ET Docket No. 03-104, at Reply 6 [hereinafter Box Reply Comments] (“By mounting U-NII nodes on power poles at appropriate intervals (between 1 and 10 miles), All the Goals of the Commission, the utilities and even the manufacturers can be achieved without causing interference to any HF users.”)

²⁵⁸ UPLC Comments, *supra* note 6, at 12.

²⁵⁹ PowerWAN Comments, *supra* note 19, at 3.

²⁶⁰ *Id.*

²⁶¹ UPLC, Reply Comments in ET Docket No. 03-104, 7 (Aug. 20, 2003) [hereinafter UPLC Reply Comments].

²⁶² NASWA Comments, *supra* note 165, at 8.

²⁶³ *Id.*

²⁶⁴ The Commission required ground penetrating radar systems to be operated below 960 MHz or in the frequency band 3.1 – 10.6 GHz; Wall Imaging Systems were required to operate below 960 MHz or in the frequency band 3.1-10.6 GHz; Through-wall Imaging Systems were required to operate below 960 MHz or in the frequency band 3.1- 10.6 GHz; surveillance systems’ operation was limited to frequency band 1.99 to 10.6 GHz; medical systems’ operations were required to be operated in the frequency band 3.1 to 10.6 GHz; vehicular radar was required to operate in the 22-29 GHz band using directional antennas on terrestrial transportation vehicles provided the center frequency of the emission and the frequency at which the highest radiated emission occurs are greater than 24.075 GHz. Attenuation of the emissions below 24 GHz is required above the horizontal plane in order to protect space borne passive sensors operating in the 23.6- 24.0 GHz

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The relative success of the UWB proceeding has been a matter of some debate. In part, this reflects the proceeding's recent vintage. Some criticism has been directed at the disparate treatment imposed upon different UWB devices. Communications devices, which received relatively light regulation under the rules, have faced far fewer hurdles than imaging and radar devices, which were severely limited in frequency range and acceptable user limitations.

In the past, allocations of unlicensed bands of spectrum have been taken to encourage the development of new technologies by encouraging manufacturers to introduce products without delays associated with licensing of radio service.²⁶⁵ In the PCS allocation proceeding, the Commission adopted a frequency allocation plan. It observed that PCS operation on an unlicensed basis would require relatively clear spectrum and identified frequency bands that were relatively lightly loaded.²⁶⁶ The Commission allocated 40 MHz in the 1890 to 1930 MHz band for unlicensed PCS services after observing the success of Part 15 unlicensed operations in bringing forth new service and devices.²⁶⁷ The Commission adopted an approach proposed by an industry consortium, the Unlicensed PCS Ad Hoc Committee for 2 GHz Microwave Transition and Management (UTAM), to coordinate relocation of fixed microwave service to other bands and to assume spectrum management functions.²⁶⁸

The Commission responded to widespread opposition to a proposed channelization plan that would have subdivided the 40 MHz and imposed power limits by instead replacing it with an industry committee-developed technical requirements for unlicensed PCS.²⁶⁹ WINForum, an industry alliance of information technology providers, proposed a spectrum etiquette that provided for equal access and sharing of the available spectrum for all users.²⁷⁰ The etiquette divided the unlicensed spectrum into two equal sub-bands, one for time critical transmissions of isochronous (voice) transmissions and one for time independent transmissions or asynchronous (high speed data) transmissions. Each sub-band has its own unique etiquette that is a combination of channelization, power, transmission time limits, and channel access parameters.²⁷¹

band; and communications and measurement systems were required to operate in the frequency band 3.1-10.6 GHz.

²⁶⁵ See In the Matter of Amendment of the Commission's Rules to Establish New Personal Communications Services, Second Report and Order, 8 F.C.C.R. 7700, ¶ 79 (1993).

²⁶⁶ *Id.*

²⁶⁷ *Id.* ¶¶ 87-88.

²⁶⁸ *Id.* ¶¶ 83-88. UTAM's responsibilities included administering the program, including negotiating costs of relocation, ensuring comparable facilities are provided, and resolving any dispute of interference to fixed microwave from unlicensed PCS operations. *Id.* ¶ 88. In cases where such matters could not be resolved, the Commission noted that the matter could be referred to the Commission for a final decision. *Id.* ¶ 88. The Commission required that coordinatable unlicensed PCS device or systems be coordinated through UTAM before being initially deployed or subsequently relocated. *Id.* ¶ 91. The Commission also required that applicants for equipment authorization be participants in UTAM. *Id.*

²⁶⁹ *Id.* ¶¶ 179-80.

²⁷⁰ *Id.* ¶ 180.

²⁷¹ *Id.*

The Commission found that the industry plan had several benefits: drawing an appropriate balance among various factors that must be taken into account by permitting all users to have equal access to the available spectrum on a shared basis; ensuring efficient use of spectrum through use of techniques such as listen-before-talk and power reduction in high-use environments; and fairness to both voice and data PCS interests by dividing available spectrum in half and applying separate rules to each, thereby allowing respective voice and data network manufacturers and service providers in each industry to merge their existing technology.²⁷² The etiquette was incorporated into the Commission's Part 15 technical standards for unlicensed PCS and requires certification of equipment that operates in the unlicensed band following the procedures in Subpart J of Part 2 of the Rules.²⁷³

The relative success of the unlicensed PCS rules is difficult to determine, as few devices have been produced to take advantage of the spectrum made available.²⁷⁴ However, the approach of an industry consensus as to frequency use ratified by adoption into the Commission's rules may provide a good model for a Commission approach to any frequency limitation and channelization plan.

If a showing of harmful interference is established, the Commission in its NPRM may wish to suggest that BPL be confined to a specific spectrum range, and leave it to the BPL industry to provide specific information regarding the practicality or impracticality of such an approach. As was noted above, there was little comment by BPL advocates on this point.

The Commission asked whether spectrum used by Access BPL is shared with In-House BPL. Ameren and other utilities indicated that there is no reason to separate the frequency ranges for In-House and Access BPL because no interference has been detected between the unconnected In-House BPL and a power line carrying an Access BPL signal.²⁷⁵ One BPL technology provider commenter said that for each transformer and cluster of homes served, an Access and an In-House system together entail only two devices transmitting at any moment and carry out similar communications functions and can be expected to have similar radio-frequency characteristics.²⁷⁶

“Accordingly, they should be subject to the same rules. Moreover, some providers may wish to offer integrated systems that deliver both access and In-House functions, and may want to install devices that participate in both. That would be difficult under disparate rules.”²⁷⁷

²⁷² *Id.* ¶ 183.

²⁷³ *Id.*

²⁷⁴ Though some might suggest that negative inferences might be drawn from the relative lack of such devices.

²⁷⁵ Ameren Comments, *supra* note 34, at 4.

²⁷⁶ Current Technologies Comments, *supra* note 18, at 17.

²⁷⁷ *Id.*

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4. Use with Coordination

Use with coordination is an approach that was taken in the UWB proceeding, in which the commission required users of some devices to coordinate use with the NTIA. With respect to BPL, the Public Safety Wireless Network concluded that frequency coordination of commercial BPL systems would likely be necessary.²⁷⁸ AMRAD said it envisioned operators having a 24/7 operations center to work in real-time to resolve interference complaints by cessation of operations in localized areas if required to resolve interference problems.²⁷⁹ However, given the pervasive and constant use of BPL systems, this approach does not appear feasible for BPL save for interference with a few key safety and scientific applications, which would probably be better addressed by complete avoidance, if possible. It is likely that the NTIA will weigh in on this approach should it prove the only means of protecting certain especially sensitive government spectrum users.

For commercial applications, the adversarial nature of the competing non-governmental uses would make such an approach perilous in cases in which both parties were private parties. An example of the problem with such contingencies noted by the ARRL is that it would pit BPL broadband consumers against amateur radio operators.

5. Limit the Range of Users

This approach was applied in the UWB proceeding, in which some UWB applications were limited to police and emergency personnel. Again, however, because of the pervasive, consumer-oriented nature of BPL devices, this approach seems inapplicable to BPL. Elements of this approach may resonate, however, with respect to the personnel that can access BPL equipment in rights-of-way, given the clear safety risk posed by medium-voltage electrical lines.

C. Part 15 Emissions Limits and Equipment Authorization

1. Application of the Part 15 Rules

Part 15 imposes emissions limits and equipment authorization standards. The Commission’s NOI noted that “high-speed BPL devices that use wide spectrum was not contemplated under the existing part 15 rules when they were formulated,”²⁸⁰ and that it was therefore not clear that the current Part 15 rules are appropriate for regulating BPL service.²⁸¹ On the other hand, as the Commission likewise noted in the NOI, it “has a long history of facilitating the introduction of new technologies under Part 15 of its rules.”²⁸² The Commission has provided new rules to govern spread spectrum technology and has amended Part 15 to provide for the special needs of unlicensed personal communications service

²⁷⁸ PSWN Comments, *supra* note 15, at 6.

²⁷⁹ AMRAD Reply Comments, *supra* note 141, at 2.

²⁸⁰ BPL NOI, *supra* note 2, ¶ 7.

²⁸¹ *Id.* ¶¶ 8-10

²⁸² *Id.* ¶ 10.

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devices, unlicensed national information infrastructure (UNII) devices and millimeter wave technology.²⁸³ A notable Commission success story is the personal computer, where the Commission limited emissions from the then novel devices enough to prevent harmful interference, but not so much as to block the development of microprocessor-based technology. In the past, the Commission has striven to “establish appropriate interference standards – conservative, but not extreme worst case” with the understanding that should such occurrence occur operations must cease.²⁸⁴

Many BPL technology providers expressed the adequacy of existing Part 15 rules and suggested that stability would best drive the new technology:

“[S]tability in the rules best serves the needs of the nascent In-House BPL industry as well as the overall public benefit. This interest is no different than that of licensed spectral holders, as rapidly shifting spectral allocations diminish the incentive for investment in equipment to utilize the allocations. Stability in rules of measurement and regulation also allows manufacturers and service providers to optimize their equipment and services to create business opportunities and effective services for the public.”²⁸⁵

Also, many In-House BPL providers said that significant deployment of In-House BPL equipment demonstrates that no further rule making is necessary.²⁸⁶

Some commenters noted that the Commission’s tradition of minimal regulation of new technologies recommends such an approach toward BPL. Comparing the development of Voice Over Internet Protocol (VOIP) service to BPL, VOIP provider Net2Phone noted, “At its outset, VOIP services experienced sound quality and connectivity problems limiting the service to a select number of users that could only make calls through their computers. Due to its unregulated treatment, rapid innovation in VOIP technologies has virtually eliminated the sound quality problems experienced in the past and led to the construction of enough gateways to eliminate the need for a PC in VOIP communications... Similarly, early BPL technologies experienced line noise, interference, and possible safety concerns. Over the past several years, however, radical improvements in BPL technologies have eliminated the quality, safety and interference concerns of the past. BPL can now serve as a true alternative for broadband service.”²⁸⁷ As noted above, however, some in the BPL industry questioned whether BPL technology advancements would solve any interference problems that remain.

²⁸³ *Id.*

²⁸⁴ Ed Thomas, Chief, Office of Engineering and Technology, FCC, *Walk DON'T Run The First Step in Authorizing Ultra-Wideband Technology*, Powerpoint Presentation, Slide 10 (Sept. 8, 2002).

²⁸⁵ Intellon Corp., Reply Comments in ET Docket No. 03-104, 4-5 (Aug. 20, 2003).

²⁸⁶ *Id.* at 9.

²⁸⁷ Net2Phone Comments, *supra* note 15, at 2.

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A number of parties suggested the Commission should hold off on new regulations. Satius, Inc. argued against imposing an RF injection limit on the power line because power line characteristic impedance would change in time and location, leading to difficulty creating a standard injection receiving test device.²⁸⁸ Verizon urged that the Commission wait to revise the Part 15 rules until after industry standards are set by an ANSI-accredited standards organization.²⁸⁹

As no commenters advanced a strong alternative to the Commission's existing Part 15 regime, it is reasonable to assume that unless BPL is banned, it will be regulated under the Part 15 rules.

2. Radiated or Conducted Emissions Limits or Both

If the Part 15 approach to regulation is applied, the Commission in the NOI asked whether a radiated or conducted emissions limit, or both, should be applied to BPL. Most BPL technology provider and electric utility commenters supported use of radiated, rather than conducted, emissions limits.²⁹⁰ Ameren, for example, noted that "no relation that could apply generally can be found between conducted emissions measured at the injection point (coupling point) and the radiated emissions from the line . . . thus, conducted emission limits may unnecessarily limit the RF energy injected into the line by BPL equipment and, therefore, the ability of the BPL system to function efficiently, without protecting other users."²⁹¹ Current Technologies said that conducted emissions outside the AM broadcast band have no bearing on interference because plug-in receivers use switching power supplies and filters at the AC input that eliminate any realistic concerns about interference from conducted emissions introduced by way of the power cord.²⁹² Likewise, electric utility and BPL technology provider commenters questioned the ability of a conducted emissions test to predict accurately the occurrence of radiated interference.²⁹³ An exception was Main.net, which suggested applying conducted emissions limits to In-House BPL and radiated emissions limits for Access BPL.²⁹⁴

ARRL strongly opposed eliminating the conducted emissions limits and contended that the power levels requested by some BPL advocates would increase conducted signals onto AC mains "by more than a million times,"²⁹⁵ presumably higher than any limit the Commission would set.

Testing results will likely determine whether a conducted emissions limit should be applied. For the time being, however, the existing limit should be retained to provide further assurance to spectrum users that their rights will not be compromised.

²⁸⁸ Satius Comments, *supra* note 48, at 4.

²⁸⁹ Verizon, Reply Comments in ET Docket No. 03-104, 1 (Aug. 20, 2003).

²⁹⁰ Southern Comments, *supra* note 33, at 23; PowerWAN Comments, *supra* note 19, at 4.

²⁹¹ Ameren Comments, *supra* note 34, at 14. *See also* Phonex Comments, *supra* note 13, at 3; UPLC Comments, *supra* note 6, at 13.

²⁹² Current Technologies Comments, *supra* note 18, at 16, 16 n.26.

²⁹³ HomePlug Comments, *supra* note 36, at 7-8; Intellon Comments, *supra* note 65, at 9-10; Ameren Comments, *supra* note 34, at 14.

²⁹⁴ Main.net Comments, *supra* note 32, at 8.

²⁹⁵ ARRL Reply Comments, *supra* note 125, at 14-15.

a. What Radiated Emissions Limit

Beyond the possibility of a ban or extreme frequency range limits placed upon BPL, the level of radiated emissions limits will likely have the most impact on the BPL business model of any action the Commission could take.

Some BPL proponent commenters pushed for loosening of radiated emissions standards for BPL. Energy companies contend that emissions limits should be relaxed because the risk of interference is negligible, technological advances have rendered existing rules obsolete, and such relaxation will improve competition, service offerings and spectrum efficiency.²⁹⁶ There would be clear bottom-line benefits to the BPL industry from such a loosening. This would economically help BPL by reducing the need for BPL signal repeaters, all the more so, proponents said, because increasing emission levels from signal repeaters and/or eliminating extra repeaters would encourage build-out in rural areas.²⁹⁷ In rural areas, distribution lines tend to be longer and the costs of deploying broadband must be spread out over a smaller universe of potential customers.²⁹⁸ These commenters also said loosened standards would also improve data rates for consumers, improving performance and service offerings.²⁹⁹

Regarding the opposing possibility of tightening emissions limits to avoid interference, one commenter noted, “The FCC should be cognizant that unless BPL can match or exceed speed achievable via cable and DSL, the basic objective of this NOI, and an important opportunity will be squandered.”³⁰⁰ Ambient contended that modem average transmitter power spectral density level needs to be set at high as –50 dBm/Hz to achieve best exploitation of overhead distribution power lines. Ambient suggested a power increase of 30 vB/m at 30 meters and encouraged continuity of field intensity limits measured at 10 meters between frequencies below –30 MHz and above – 30 MHz to enable a frequency range reaching at least 40 MHz and a “significantly greater” rate of data on typical overhead medium voltage lines.³⁰¹

Ambient attempted to characterize the sensitivity of Access BPL systems to power reductions by stating that a 12 dB reduction of power on its New York system resulted in a reduction of data rates by a factor of approximately 4.³⁰² The upside from reducing emissions limits was judged by one BPL technology provider as relatively more modest, with a doubling of the distances between repeaters by increasing power limits resulting in a 5% improvement in the

²⁹⁶ Southern Reply Comments, *supra* note 15, at 24-25 (also citing Electric Broadband Comments, *supra* note 28, at i, 8 that increased emissions limits would not result in any harmful interference); PowerWAN Comments, *supra* note 19, at 3.

²⁹⁷ PowerWAN Comments, *supra* note 19, at 3.

²⁹⁸ Southern Reply Comments, *supra* note 15, at 28. As noted above, however, questions have been raised regarding whether Access BPL deployment is economically feasible or likely with respect to rural customers. See discussion *supra* at Part III(A)(i).

²⁹⁹ Ambient Comments, *supra* note 34, at 5; Electric Broadband Comments, *supra* note 28, at 9; PowerWAN Comments, *supra* note 19, at 3.

³⁰⁰ Ambient Comments, *supra* note 34, at 5.

³⁰¹ *Id.*

³⁰² *Id.* at 5-6.

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valuation of a BPL network.³⁰³ An important conclusion, therefore, is that existing emissions standards are relatively acceptable but that tightened standards could seriously impede BPL's performance.

Other BPL technology providers said that while they would eventually welcome eased emissions standards, the standards should remain where they are at present because of the opposition that would be generated if standards were lowered.³⁰⁴

Shortwave broadcasters urged that a stricter standard for emissions be set in the event that BPL was allowed by the Commission. Some commenters contended that even if BPL were compliant with existing Part 15 rules, the resulting increase in emissions would force amateur radio operators to increase transmitting power from 1500 watts to 150 kilowatts or expand a 33-foot doublet antenna to a multi-tower curtain array covering many acres of land.³⁰⁵

Interference testing in commercial deployments or by the NTIA or FCC should be used to determine the proper change, if any, to the Part 15 Rules. The burden should be on the electric utilities to demonstrate the need for such loosening. As one BPL technology provider noted, the relative gain from such a loosening is relatively less important to BPL than averting a significant tightening of the radiated emissions limit.

The Commission should be cognizant of its policy of providing a level playing field among broadband competitors.³⁰⁶ As one commenter noted, other broadband technologies use Part 15 devices, yet are not requesting a lessening of emissions standards by the Commission.³⁰⁷ BPL should not be subsidized, nor exempted from otherwise applicable regulations, if it suffers from an interference liability not shared by competitors.

b. Class A or Class B Classification above 30 MHz

As noted above, BPL uses above 30 MHz would likely be classified as either Class A or as the more rigorous Class B residential classification.³⁰⁸ Energy companies and BPL technology companies predictably advocated the former³⁰⁹ and other licensees and spectrum users, equally predictably, favor the latter.³¹⁰ ARRL said that BPL should be classified as residential since it would be installed on medium-voltage lines that supply electricity to a residential neighborhood and would not and could not be restricted to commercial or industrial environments by

³⁰³ Conversation of David Shpigler with author David Tobenkin, 10/24/03.

³⁰⁴ See, e.g., Current Technologies Comments, *supra* note 18, at 14.

³⁰⁵ Tope Reply Comments, *supra* note 114, at 5.

³⁰⁶ Kevin J. Martin, Remarks of Commissioner Kevin J. Martin, Federal Communications Commission, to the Santa Fe Conference of the Center for Public Utilities Advisory Council, Santa Fe, New Mexico (March 18, 2003) (noting that the Commission "agreed to level the playing field between phone companies and cable companies competing to provide broadband services" and not pick "winners and losers").

³⁰⁷ Keane Reply Comments, *supra* note 219, at 18.

³⁰⁸ Though creation of a whole new category for the technology is also a possibility.

³⁰⁹ UPLC Comments, *supra* note 6 at 12. A partial exception was Current Technologies, which indicated that the Commission might wish to apply the Class B standard to Access BPL operated in TV and FM bands in residential areas. Current Technologies Comments, *supra* note 18, at 17.

³¹⁰ ARRL Reply Comments, *supra* note 125, at 12-14.

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its nature.³¹¹ “The Class B environment and rules are intended to protect residential environments from nearby *external* sources. Clearly this should apply to any systems connected to residential building and distribution wiring.”³¹²

The UPLC, by contrast, said that the less restrictive commercial Class A emission standard should apply to access BPL on medium voltage lines.³¹³ The UPLC and energy utilities said that the Class A standard is appropriate because medium-voltage lines never enter the home or pose an interference threat to consumer electronic equipment.³¹⁴

Spectrum licensees may have a strong argument if medium-voltage emissions compromise licensee signals. As noted, Class B limits were designed to prevent interference between devices of different neighbors.³¹⁵ Neighbors who enjoyed receiving shortwave radio, for example, could clearly see their use compromised by BPL interference.³¹⁶ On the other hand, interference concerns at these higher frequencies are generally of less concern to spectrum users and the difference in emissions is not too significant absolutely and to device performance. The Commission’s classification decision should be driven by test results.

3. Equipment Authorization

The Commission asked what components of a BPL system should be subject to equipment authorization.³¹⁷ Some commenters indicated that certain components necessary to establish Access BPL that contributed to radiation at different degrees should be subject to equipment authorization procedures, such as the RF coupler, which conveys signals between an access device and the power line. One commenter stressed the need to consider all system components as they operate together, rather than individually.³¹⁸

The Commission will be forced to choose between the less rigorous Verification and the more rigorous Certification and Declaration of Conformity equipment review processes. One major impact of the imposition of the procedure of Certification is that it may slow the release of new equipment to the marketplace, sometimes by as much as 60 days, as well as possible further delays caused by testing each time technological changes are necessitated by advances in

³¹¹ ARRL Comments, *supra* note 112, at 13.

³¹² ARRL Reply Comments, *supra* note 125, at 8 (emphasis in original). *See also* NASWA Comments, *supra* note 165, at 5.

³¹³ UPLC Comments, *supra* note 6, at 12.

³¹⁴ PowerWAN Comments, *supra* note 19, at 3-4; Amerion Comments, *supra* note 15, at 6; Main.net Comments, *supra* note 32, at 5 (“the typical operation of an Access Medium Voltage BPL would normally never place the unit closer than 30 feet from a residential broadcast receiver.”); Electric Broadband Comments, *supra* note 26, at 8 (“proximity to residential dwellings is limited by the [National Electrical Safety Code]”); Current Technologies Comments, *supra* note 18, at 17. Progress Energy, however, indicated that it assisted Amerion in establishing Class B compliance of Amerion equipment, suggesting the Class B requirement may not be excessively onerous. Progress Energy Comments, *supra* note 19, at 6.

³¹⁵ *See* discussion generally *supra* at Part IV(A)(i)(b).

³¹⁶ NASWA Comments, *supra* note 165, at 5.

³¹⁷ BPL NOI, *supra* note 2, ¶ 26.

³¹⁸ Ameren Comments, *supra* note 34, at 19.

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the technology. Current Technologies noted that “the Commission does not subject any unintentional radiators to certification (except radar detectors, which the Commission found to pose a specific threat).”³¹⁹ The UPLC recommends that FCC retain current equipment Verification process as BPL equipment will be marketed only to utilities and third-party service providers, never to consumers. “Because it connects to the electric distribution lines, it must – and will—always be professionally installed by qualified linemen.” Current Technologies suggested that Verification be allowed for pole and enclosure-mounted BPL equipment and that equipment that plugs into outlets or attaches to low-voltage wiring be subject to Verification or Declaration of Conformity, but not Certification.³²⁰

ARRL said Verification is not adequate because of typical errors measuring in the field,³²¹ and that, rather, Certification should be required.³²² ARRL says that certification is also better because it would force sufficient test results to be released publicly: “With Verification, manufacturers are under no obligation to provide test data to anyone. In ARRL’s several years of experience, there has been only one instance in which a manufacturer of a Part 15 device has been willing to supply such data upon ARRL’s request.”³²³ Some electric utility commenters said that equipment venders are already certifying their equipment.³²⁴ Narrow band BPL technology company xGT suggested that certification or Declaration of Conformity procedures were warranted for new Access and In-House BPL equipment due to its greater potential for causing harmful interference to licensed radio services.³²⁵

Certification or Declaration of Conformity should be imposed upon customer premises and low voltage equipment given heightened concerns regarding interference from BPL until test results determine if such concerns are unwarranted.³²⁶ Upon a showing of a pervasive threat of interference from pending tests, this should also be the standard for medium-voltage line equipment. In addition to according spectrum users heightened protection, a heightened standard of technical review will provide the Commission a valuable source of information regarding BPL systems and interference concerns by heightening testing standards and documentation. The sole exception of this requirement should be if BPL proponents demonstrate that certification would result in substantial delays would result to deployment of BPL technology.³²⁷ Even then, a

³¹⁹ Current Technologies Comments, *supra* note 18, at 20.

³²⁰ *Id.*

³²¹ ARRL Reply Comments, *supra* note 125, at 10.

³²² *Id.*

³²³ *Id.* at 11.

³²⁴ Hawaiian Electric Comments, *supra* note 20, at 3-4 (indicating that BPL trial venders have obtained certification for their Access BPL equipment and that BPL venders offering consumer products have such equipment Part 15 certified); Florida Power Comments, *supra* note 25, at 7.

³²⁵ xGT Comments, *supra* note 34, at 7.

³²⁶ The Commission may wish to consider an initial period of heightened scrutiny that will sunset unless renewed.

³²⁷ Though the lack of comments to this effect in the record suggests that such concerns are not widely held. One commenter noted in confidence, however, that certification classification could require that routine technical changes be subjected to testing and thereby increase the possibility of delays.

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heightened form of verification, including full disclosure to other spectrum users, should be imposed.

D. Enforcement

Many spectrum user commenters questioned whether the Commission would be willing to enforce Part 15's requirement that unlicensed interfering devices must terminate their services in the event of such interference with licensed spectrum users, a position that even one BPL proponent conceded was valid in the case of BPL, which would likely pit a relatively small number of licensed users against the power of a local utility and a large number of disgruntled end users. The North American Shortwave Association cited the enforcement issues posed at the 27 MHz band, where a decision by the Commission to eliminate licensing of Citizens Band operators has led to widespread rule violations and generally ineffective enforcement by the Commission. As NASWA said, "once the egg is out of the chicken, you cannot stuff it back in."³²⁸ Many amateur radio operators alleged that a lack of responsiveness by local utilities in after being notified of RF interference suggests that BPL could follow the same path.³²⁹

However, the limited nature of BPL foreseeable deployments, the planned NTIA and Commission Staff Tests, and the use of aggressive testing at commercial sties should enable the Commission to identify and address such concerns. The Commission should honor its obligations to licensed spectrum users by requiring BPL providers to take steps to facilitate enforcement by the Commission and spectrum users and by then aggressively enforcing its rules. The Commission should take an aggressive and proactive stance in its NPRM that compliance with Part 15 will mean strict compliance, regardless of the volume of complaints by BPL end users affected by such enforcement decisions.³³⁰ Most importantly, it should carefully design conservative rules that will help avert enforcement dilemmas.

E. Adoption of Equipment and Testing Standards

As noted, the NOI requested a wide range of information regarding standards for Access BPL and In-House BPL and asked what steps it should take to facilitate the development of standards.³³¹ The BPL provider and electric utility commenters generally felt that some standards would be helpful but many questioned whether the Commission should intervene to set standards.

³²⁸ NASWA Reply Comments, *supra* note 252, at 2.

³²⁹ See Paul Kasley, Reply Comments in ET Docket No. 03-104, 2 ("I have found Commonwealth Edison to be generally unresponsive to my complaints of interference from their equipment. Only when I am able to pinpoint the exact location of their hash generators and I directly and continually telephone the responsible department do I get action.").

³³⁰ Spectrum licensees must also do their part by to resolve interference disputes by attempting resolutions with utilities before seeking action by the Commission, which may result in expedited resolution of conflicts and which will conserve Commission resources.

³³¹ BPL NOI, *supra* note 2, ¶ 17.

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BPL proponents indicated that there were areas where standards clearly would help. The UPLC noted, for example, that most signal loss tends to occur at the coupler, so the more efficient the technique, the lower the emission measurements will tend to be, if other things are equal.³³² Still, it recommended that the FCC should not set such standards: “the Commission need not adopt rules with respect to specific coupling technologies. Rather, it should continue simply to set technology-neutral emissions limits and enable manufacturers to utilize the most efficient coupling techniques consistent with such limits.”³³³ As always is the case with new technologies, premature selection of standards could unnecessarily foreclose innovative network designs. In addition, an executive of one BPL technology provider told the authors in confidence that he felt that shake-out and consolidation in the industry among providers would lead to such standards.

Similarly, a number of commenters believe that the Commission should allow the industry to develop standards or design systems to avoid conflict between Access BPL and In-House BPL Systems.³³⁴ In particular, apart from confining BPL to address concerns over interference with other uses, discussed above, many technology providers and energy partners contended that particular frequencies should not be designated to avert interference between Access or In-House BPL systems.³³⁵

Standards have been advocated by European regulators. The European Commission’s Radio Spectrum Committee’s report, *Broadband Communication through Power Lines*, concluded that “it would seem appropriate to consider adopting an interference model based on radiated measurements, made on an open field site and performed at different installations that can be demonstrated to be representative of typical installation sites.”³³⁶ The working document said that an early attempt at setting BPL standards had languished because of divergent positions among industry participants.³³⁷

In a rare point of agreement, however, one BPL technology provider and ARRL agreed that international standards do not appear to be easily adaptable to U.S. BPL: “PowerWAN states that BPL standards work has not been done internationally other than through ETSI. PowerWan believes that it is still too early for standards work to be successfully embarked upon, as there are no deployments large enough to provide the real-world experience to prove or disprove technologies and techniques. ARRL agrees with this assessment.”³³⁸

³³² UPLC Comments, *supra* note 6 at 11.

³³³ *Id.*

³³⁴ Current Technologies Comments at 3, 17-18; UPLC Reply Comments, *supra* note 261, at 5; Phonex Comments, *supra* note 13, at 2.

³³⁵ Southern Reply Comments, *supra* note 15, at 8; Ameren Comments, *supra* note 261, at 3-4.

³³⁶ EC Working Document, *supra* note 241, at 5-6.

³³⁷ *Id.* at 5.

³³⁸ ARRL Reply Comments, *supra* note 125, at 22. PLC organization leaders have reached similar conclusions regarding efforts to create a standard in Europe. See EC Nudges Member States to Deploy Broadband Over Power Lines, COMMUNICATIONS DAILY, July 28, 2003 (quoting UPLC director of regulatory services Brett Kilbourne that possible European PLC standards would likely not serve as a model for U.S. BPL providers). Some commenters submitted a wide range of international studies into the record. See NASWA Comments, *supra* note 165, at 9-12.

Verizon urged that any standards be developed with the participation of potential victims of BPL interference.³³⁹ Verizon noted that interference problems related to a high-speed home networking technology were resolved through development of a set of specifications that excluded use of the amateur radio frequency spectrum.³⁴⁰ Rural electric cooperative commenters urged the Commission to encourage the adoption of standards to help such utilities investing in BPL technology from investing in a single provider's technology only to see another incompatible standard eventually prevail.³⁴¹

The Power System Relaying Committee of the Institute of Electronic and Electrical Engineers recommended standardization of Access BPL and In-House BPL output characteristics, modulation schema and other standards to allow interoperability and similar equipment provider interpretations of Part 15.³⁴²

Some broadcast spectrum commenters suggested equipment standards might address their interference concerns. The National Academy of Sciences suggested that unwanted radiation from BPL could be minimized by keeping the BPL system perfectly balanced, with equal currents flowing in each of the two conductors and with close spacing between the balance conductors.³⁴³ Southern said in response that while it is impossible to have a system that is perfectly balanced, it is studying balanced injection.³⁴⁴

It is our view that it is indeed early to set standards. Further tests, first commercial deployments, and possible changes to the Part 15 rules will set the stage for development of standards in the future, with participation of international standard institutions. But the Commission should certainly encourage and help expedite the development of such standards in a competitively neutral fashion.

F. Safety Concerns

Qwest suggested that to the extent BPL interconnects with the telephone network, the Commission should require BPL providers to demonstrate that the interconnection will not endanger ILEC services, facilities, or technicians and should require complete physical separation of BPL service from its underlying transmission facilities before handing off the signal to an ILEC or to the inside wiring at a customer's premises.³⁴⁵ Electric utilities responded that they had an excellent record of safety and had every incentive to monitor interconnections between electric and telephone facilities to avoid impairing their own facilities.

Electric utility employees should take the lead in providing service to BPL systems, even in BPL business model situations in which utilities license others to act on their behalf. Other than such precautions, however, it is difficult to see the

³³⁹ Verizon Comments, *supra* note 155, at 6.

³⁴⁰ *Id.* at 7.

³⁴¹ NRTC/NRECA Reply Comments, *supra* note 16, at 7-8.

³⁴² IEEE Comments, *supra* note 170, at 4.

³⁴³ NAS Comments, *supra* note 153, at 4.

³⁴⁴ Southern Reply Comments, *supra* note 15, at 20-21.

³⁴⁵ Qwest Comments, *supra* note 155, at 3-4.

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need for specialized regulations governing interconnection with telephone networks.

G. Policy and Political Considerations

While technological findings should govern a technical proceeding, a variety of policy consideration should also leaven the Commission's analysis of the BPL regulatory challenge.

A first consideration is the Commission's duty to help promote new technologies. Various statutory enactments and Commission policies commit it to fostering the development of new technologies. Section 706 of the Telecommunications Act of 1996 requires the Commission to "encourag[e] the deployment on a reasonable and timely basis of advanced telecommunications capability to all Americans" by "regulatory forbearance, measures that promote competition... or other regulating methods that remove barriers to infrastructure investment."³⁴⁶

A regulatory light-touch toward BPL echoes the overall policy of the Commission toward broadband policy development:

The third goal of the Commission's broadband policy is to promote investment and innovation in a competitive market by ensuring that broadband services exist in a minimal regulatory environment. We recognize that substantial investment is required to build out the networks that will support future broadband capabilities and applications. Therefore, our policy and regulatory framework is designed to foster investment and innovation by limiting regulatory uncertainty and unnecessary or unduly burdensome regulatory costs. The need for regulation greatly diminishes as the new and multiple platforms described above develop.³⁴⁷

Politically, the Commission appears squarely in the corner of BPL. At the UPLC Annual Conference held in September, Commissioner Kathleen Abernathy spoke of her interest in the technology and its possible role in ushering a "broadband Nirvana" of multiple competing broadband technologies.³⁴⁸ Judging by Abernathy's comments and those of other commissioners, the question is not whether BPL will be allowed, but how its advent can be accelerated. "There is little question that BPL services will compete with more-established cable modem and DSL services – and in some markets, satellite and fixed wireless services."³⁴⁹

³⁴⁶ Telecommunications Act of 1996, Pub. L. No. 104-104, Sec. 706, 110 Stat. 56 (1996).

³⁴⁷ Statement of Robert Pepper, PhD, Chief, Policy Development Office of Strategic Planning and Policy Analysis, Federal Communications Commission, Committee on House Energy and Commerce Subcommittee on Subcommittee on Telecommunications and the Internet (July 21, 2003).

³⁴⁸ Abernathy UPLC Speech, *supra* note 236, at 1.

³⁴⁹ *Id.* at 3. In fairness to Commissioner Abernathy, her speech to the UPLC Conference did, albeit briefly, call attention to the need for "strict interference rules to prevent competitors from externalizing their costs" and did stress that interference rules were necessary: "Although, as I have noted, the Commission was right to refrain from imposing heavy-handed price and service-

Such statements have indeed led to confidence on the part of some BPL Technology companies:

Jay Birnbaum, pres. of Current Technologies, which is involved in trials by Cinergy in Cincinnati and PEPCO in Potomac, Md., said the companies were working toward a commercial start in the 4th quarter. He said the FCC's inquiry would not affect the deployment: "There is nothing in there that would give us cause to delay." Asked whether he anticipated any change in the FCC's rules, Birnbaum said he didn't see the agency lowering the emission standards because there was no reason to do so. The Commission itself brought up the issue in its inquiry, he said, and "raised the prospect of increasing the limits in some areas in some bands."³⁵⁰

Many BPL technology providers and electric utilities likewise emphasized the importance of speedy action in the proceeding:

"The regulatory uncertainty of a drawn-out proceeding may limit the ability of BPL service providers and technology developers to raise capital. And, once the broadband market is saturated, all broadband competitors will be significantly inhibited in raising capital to deploy their networks and market their services."³⁵¹

But while the Commission has a long tradition of providing an initial period of lessened regulation to new media forms, and in the case of BPL appears poised to do so by allowing entry without such imposition of laws to govern issues including open access and statutory classification, that policy should not be extended to technical rules. The Commission should consider carefully before deferring to industry arguments that loosened restrictions would stimulate development of the medium.

By all accounts, the Commission's regulation will not be the decisive factor in driving BPL. More important by far will be utilities' ability to realize utility-side benefits, BPL's ability to rapidly enter markets where there is no entrenched competitor and compete effectively against established competitors in remaining markets, the profitability of broadband applications generally, the risk sensitivity of the electric utilities and their willingness to invest, and the relative cost of BPL customer premises equipment.³⁵² BPL has been held back to date

quality regulations on PCS services when they were introduced, it was also right to adopt strict interference rules to prevent competitors from externalizing their costs." *Id.* at 4.

³⁵⁰ *Manassas (Va.) Set to Roll out Broadband over Power Line*, WASHINGTON INTERNET DAILY, August 27, 2003.

³⁵¹ Current Technologies Comments, *supra* note 18, at 12.

³⁵² See Dinesh Kumar, Utilities Unveil Time Lines for Commercial Broadband Deployment, COMMUNICATIONS DAILY, Sept. 23, 2003 (describing concerns about prospects for BPL by investment bankers as driven by technical feasibility, tardy deployment, relative competitiveness, and availability of capital); Teri Rucker, *Broadband: Powerful Interests Align Against Power-line Internet Service*, NATIONAL JOURNAL'S TECHNOLOGY DAILY, Dec. 11, 2003 (quoting BPL

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fundamentally by its own technical difficulties, business challenges³⁵³, and by a shortage of investment by the utilities that presumably have the most to gain from it. If BPL cannot stand on its own two technical and financial feet, it should not be propped up by Commission incentives such as loosened emissions standards, with the possible exception of markets in which there are no broadband available and no prospective competitors.³⁵⁴ An overly supportive policy may engender little additional BPL investment, while endangering licensed and other unlicensed spectrum users.³⁵⁵

As noted above, competitive neutrality is another important Commission principle. In the broadband arena, promoting one form can inadvertently impair another and the Commission should proceed in a cautious and competitively neutral fashion. As noted, wireless Internet service providers contended that deployment of BPL in at least one form could impede their own launch of wireless service and endanger use of spectrum whose availability their deployment was predicated upon. Likewise, the Commission should take care to ensure that its technical standards for BPL do not unfairly act to compensate for any inherent shortcomings in the technology and thereby favor it in the race against other broadband technologies. On the other hand, if increasing the emissions limits for BPL can be demonstrated to pose no heightened interference threat to spectrum users, the Commission should by all means consider such an increase.

The Commission must be open to the possibility (though not necessarily the probability) that copper twisted pair is an end user communications medium inherently inferior to, and more interference prone, than wireless and other wire applications. One commenter noted that the bandwidth needs of the utility management aspect of BPL is far narrower than that of the end user applications. Given the disproportionate and unique benefits of such uses, it is possible BPL's niche may be in large parts of the country limited to such service. Should evidence begin to mount that BPL interference concerns are significant, the Commission and BPL proponents may wish to segregate consideration of how to facilitate BPL utility support services apart from consumer applications to allow

industry attorney Raymond Kowalski as noting that "the electric industry is still trying to figure out if they want" to be in the broadband business).

³⁵³ A lower number of households per transformer compared to Europe makes Access BPL comparatively much more expensive in the United States. See Jennifer Alvey, *It's now or never for Power Line broadband: can utilities make a credible play for power line communications?*, PUBLIC UTILITIES FORTNIGHTLY, Feb. 1, 2003, at 37. In addition, more of Europe's network is underground and uses shielded cable than that of America. *Id.*

³⁵⁴ Even then, given rapidly emerging competition from satellite and wireless competitors, it is questionable how many communities would truly benefit from such preferences. See NRTC/NREC Joint Reply Comments, *supra* note 16, at 4 (holding out more hope from satellite broadband providers for service to rural residents). A showing that the commercial deployment of service by any other broadband provider in an area is very unlikely, however, should trigger consideration of preferential treatment for BPL.

³⁵⁵ Many spectrum users also noted that one principle of Commission radio frequency regulation is efficiency and that the Commission has acted before to assure efficiency by banning highly inefficient uses. Spark transmitters, for example, a key maritime communications device, were outlawed because they created severe interference to other radio services over wide areas.

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this vital use to progress while more contentious consumer application issues are sorted out.

More fundamentally, should interference concerns proved credible, the benefits of unfettered deployment of BPL must be carefully weighed against the potential loss of smaller voices. The potential to largely preclude shortwave broadcasters, if so demonstrated, should not be taken lightly. While shortwave has largely been overtaken by more powerful communications technologies, it remains another, redundant form of communication not reliant upon large wireline communications networks. Commenters note it is the only signal that can directly carry around the globe, allowing a broadcaster in one country to directly communicate with another.³⁵⁶ Shortwave allows such access without a monthly subscription fee, unlike broadband³⁵⁷ and, unlike Internet connections in many totalitarian countries, are not under the control of national governments.³⁵⁸ It is confined to a specific frequency range that cannot be adjusted. Likewise, with respect to radio astronomy, one commenter thoughtfully noted that “one cannot change the radio frequency allocation for the Sun and Jupiter.”³⁵⁹

VI. Conclusion

The proceeding record to date reveals BPL as an industry that has made substantial strides in addressing previously debilitating technical challenges. The BPL technology is approaching the level of maturity necessary to be commercially deployed and even competitors conceded that the record demonstrated that BPL will likely be an effective broadband competitor.³⁶⁰

However, the existing body of testing and modeling performed in the area of BPL is not adequate to make a definite decision on the appropriate technical rules for the medium. The polarity of views on the issue of interference suggests that it remains a significant point of contention that should be addressed in more detail. Given the difficulty of modeling the BPL RF distribution and little practical experience in deploying such large-scale systems potentially functioning as unintentional RF emitters, the Commission should emphasize the need for pilot commercial rollouts on a sufficient scale to perform system testing in ‘near-real’ conditions. The initial deployments by electric utilities and their partners will not be so extensive that the *fait accompli* concerns of amateur radio operators and others is likely. The Commission and the NTIA’s tests and results from early commercial deployments of BPL should likely determine the level of caution required.

³⁵⁶ See NASWA Comments, *supra* note 165, at 1; See also Box Reply Comments, *supra* note 257, at Replies 1, 4 (“Of the entire electromagnetic spectrum, from DC to light, only the tiny sliver between 1 and 30 MHz is capable of unassisted, worldwide communication using little power and absolutely no infrastructure. . . No network based on a man made infrastructure can ever be as reliable as one that requires no infrastructure”).

³⁵⁷ NASWA Comments, *supra* note 165, at 2.

³⁵⁸ *Id.* at 16.

³⁵⁹ Nikolaus Leggett, Additional Comments in ET Docket No. 03-104, 3 (May 29, 2003).

³⁶⁰ See Verizon, Reply Comments in ET Docket No. 03-104, 1 (Aug. 20, 2003) (“Most commenters agree that BPL has the potential to compete head-to-head with other broadband services.”).

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The Commission should apply its existing Part 15 rules to BPL, but should be prepared to consider confining BPL to a spectrum band (at least initially) that would harm a reduced level of licensed and competing spectrum users should interference concerns prove well-founded and if notching techniques do not mitigate such interference. The Commission may also wish to further investigate the possible ways of allocating an unused frequency band for BPL, keeping in mind the current trends in frequency allocation and the move to digital signal broadcasting. Until the tests provide conclusive data concerning RF emissions and equipment safety, both In-House and Access BPL equipment within buildings and on low-power lines should be viewed as belonging to Class B, residential, and the Commission should consider applying this treatment to medium-voltage equipment as well upon a showing of likely harmful interference. Emissions limits should not be altered, unless the BPL industry can demonstrate no interference harm would result.

BPL providers should be strongly encouraged to build out their systems to sufficient scale, and with a sufficient diversity of operating conditions and configurations, and to collect and retain records of such operations, so as to enable the Commission to gain as full a picture of possible interference concerns as soon as possible. All sides should submit updates to the record on a regular basis to assure that the Commission is fully informed on the status of the technology and operating issues. The Commission must also vigorously enforce its Part 15 rules.

BPL will put its proponents to the test with respect to technical and economic feasibility, commercial demand, and interference challenges. It may likewise force the Commission and licensed spectrum users to define their measurement and approaches toward new communications media that promise value but threaten possibly pervasive yet variable interference. For all sides, whatever BPL's ultimate degree of success, the knowledge gained from addressing its challenges may prove as valuable as the service itself. As the familiar adage runs: nothing ventured, nothing gained.